PRODUCING OIL AND GAS ON THE U.S. OUTER CONTINENTAL SHELF: CO_2E EMISSIONS AND THE SOCIAL COST OF CARBON

Prepared for Oceana

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II. Executive Summary

Our oceans provide a wealth of benefits to the United States, sustaining more than 3 million jobs and contributing more than $300 billion to the U.S. economy in 2018[1]. Nearly 49 million U.S adults visited the oceans and coasts in 2012[2], looking for clean beaches and healthy waters. The oil and gas development associated with the lease sales from the "2019-2024 National Outer Continental Shelf Draft Proposed Program" (2019-2024 DPP) would put these jobs and this economic value at risk and generate additional costs associated with other forms of economic output, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change, with a total cost of $723 billion or more.

The National OCS Oil and Gas Leasing Program (National OCS Program) for oil and gas development, administered by the Bureau of Ocean Energy Management (BOEM), establishes a schedule of oil and gas lease sales proposed for planning areas of the U.S. Outer Continental Shelf (OCS). In 2016, BOEM published a report that examined the lifecycle greenhouse gas emissions (measured as carbon dioxide equivalent, or CO_2e) and social cost of carbon (SCC) associated with oil and gas development in the U.S. Outer Continental Shelf (OCS)[3]. In 2018, BOEM published the 2019-2024 DPP proposing the expansion of oil and gas development on the OCS[4]. This report uses the methods and data used in BOEM's 2016 report to estimate the lifecycle CO_2e emissions and SCC associated with the 2019-2024 DPP plan for oil and gas development in the OCS.

Economic losses associated with the impacts caused by the release of CO_2e into the atmosphere (e.g., climate change and ocean acidification) are referred to as the "social cost of carbon" (SCC). Essentially, SCC is "a measure, in dollars, of the long-term damage done by a ton of carbon dioxide (CO2) emissions in a given year"[5]. SCC can also represent the value of damages avoided for emission reductions (i.e., the benefit of a CO_2e reductions). The economic effects of releasing carbon into the atmosphere continue long into the future and increase as the total concentration of atmospheric carbon increases. These losses include such wide-ranging effects as changes in economic output, human health, property damages from increased flood risk, and the value of ecosystem services.

[1] NOAA Report on the U.S. Marine Economy. 2020

[2] NOAA, 2018. National Ocean Recreation Expenditure Survey. https://spo.nmfs.noaa.gov/sites/default/files/TMSPO185_REV.pdf accessed December 21, 2020.

[3] Bureau of Ocean Energy Management, 2016. OCS oil and Natural gas: potential lifecycle greenhouse gas emissions and social cost of carbon.

[4] Bureau of Ocean Energy Management, 2018. 2019-2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program.

[5] EPA. 2017. The Social Cost of Carbon. (archived)

The 2019-2024 DPP proposes opening all 22 planning regions comprising the OCS to oil and gas development. The Bureau of Ocean Energy Management (BOEM) estimates that the Undiscovered Economically Recoverable Resources (UERR) in unleased portions of the OCS range from 37.5 billion to 68.2 billion barrels of oil and 59.4 trillion to 174.0 trillion cubic feet of natural gas. This equates to six to eleven times the 2018 oil production level for the entire U.S. and two to six times the 2018 natural gas production level[6]. In their 2018 report, "2019-2024 National Outer Continental Shelf Draft Proposed Program" (2019-2024 DPP), BOEM proposes production throughout remaining unleased portions of the OCS. The analysis reflected in this report assumes that all UERRs will be extracted during the 50-year period of 2024 to 2074.

BOEM's 2019-2024 DPP presents three UERR values that correspond to scenarios reflecting low, medium, and high oil and gas price levels. Analysis performed as part of this study indicate that the high oil and gas scenario is unlikely to occur, based on the historical range of oil and gas prices. For this reason, this report uses the more conservative approach of focusing on the low and medium oil and gas price scenarios; future oil and gas prices corresponding to the high-price scenario would result in even higher CO_2e emissions and social costs than described in this report.

This analysis finds that the development of these areas and the production and consumption of the crude oil and natural gas located in the currently unleased portions of this area would result in greenhouse gas emissions ranging from 19.4 billion tons to 33.8 billion tons of CO_2e between 2025 and 2074. This equates to 3 to 5 years of carbon releases in the U.S. from all sources[7] at 2018 emission rates. For further comparison, 19.4 billion tons of CO2e is equivalent to taking every car in the U.S. off the road for about 15 years.[8,9].

Economic models that estimate the cost of CO_2e emissions to society (the "social cost of carbon," or SCC) provide a broad range of results corresponding to different assumptions about future economic conditions and the appropriate level of risk-taking with regard to climate policy. Using SCC estimates based on conservative assumptions, the SCC associated with the 2019-2024 DPP ranges from $723 billion to $1.2 trillion. The smaller of these two figures is about the same as the 2018 gross domestic product (GDP) for the Chicago metropolitan area,[10] and is more than the annual GDP of major cities such as Washington, Dallas/Fort Worth, Boston, Atlanta, Seattle, and Miami. The larger of these two figures is greater than the 2018 GDP for the Los Angeles metropolitan area which is the second largest metropolitan area in the country, measured in terms of GDP. It is important to note that the figures in this report are

[6] Computations by TBD Economics, comparing the results of this analysis with data from the Energy Information Administration, 2020. Natural Gas Consumption by End Use and Energy Information Administration, 2020. U.S. Refinery Net Input.
[7] Computations by TBD Economics, comparing the results of this analysis with data from Environmental Protection Agency, 2020. Inventory of US greenhouse gas emissions and sinks: 1990–2018.
[8] The Environmental Protection Agency's "Green Vehicle Guide" states that "[a] typical passenger vehicle emits about 4.6 metric tons of carbon dioxide per year."
[9] Bureau of Transportation Statistics. Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances. 2020.
[10] Bureau of Economic Analysis, 2020, Regional Data.

based on values that were selected from the lower half of the ranges published for both the SCC and the volume of oil and gas that will be produced and consumed; thus, the true cost of implementing the 2019-2024 DPP could be significantly higher.

The methods and data sources for this analysis are based on those used in a 2016 report by BOEM that examined the lifecycle greenhouse gas emissions and social cost of carbon associated with the previous plan for oil and gas development in the OCS[11].

[11] Bureau of Ocean Energy Management, 2016. OCS oil and Natural gas: potential lifecycle greenhouse gas emissions and social cost of carbon.

III. Overview

The National OCS Oil and Gas Leasing Program (National OCS Program) for oil and gas development, administered by the Bureau of Ocean Energy Management (BOEM), establishes a schedule of oil and gas lease sales proposed for planning areas of the U.S. Outer Continental Shelf (OCS). In 2016, BOEM published a report that examined the lifecycle greenhouse gas emissions (measured as carbon dioxide equivalent, or CO_2e) and social cost of carbon (SCC) associated with oil and gas development in the U.S. Outer Continental Shelf (OCS)[12]. In 2018, BOEM published the "2019-2024 National Outer Continental Shelf Draft Proposed Program" (2019-2024 DPP) proposing the expansion of oil and gas development on the OCS[13]. This report uses the methods and data used in BOEM's 2016 report to estimate the lifecycle CO_2e emissions and SCC associated with the 2019-2024 DPP plan for oil and gas development in the OCS.

Economic losses associated with the impacts caused by the release of CO_2e into the atmosphere (e.g., climate change and ocean acidification) are referred to as the "social cost of carbon" (SCC). Essentially, SCC is "a measure, in dollars, of the long-term damage done by a ton of carbon dioxide (CO2) emissions in a given year"[14]. SCC can also represent the value of damages avoided for emission reductions (i.e., the benefit of a CO_2e reductions). The economic effects of releasing carbon into the atmosphere continue long into the future and increase as the total concentration of atmospheric carbon increases. These losses include such wide-ranging effects as changes in economic output, human health, property damages from increased flood risk, and the value of ecosystem services.

The 2019-2024 DPP proposes opening all 22 planning regions comprising the OCS to oil and gas development. In the unleased portions of these planning areas[15], Undiscovered Economically Recoverable Resources[16] (UERR) range from 37.5 billion to 68.2 billion barrels of oil and 59.4 to 174.0 trillion cubic feet of natural gas. These values equate to six to eleven times the 2018 oil

[12] Bureau of Ocean Energy Management, 2016. OCS oil and Natural gas: potential lifecycle greenhouse gas emissions and social cost of carbon.

[13] Bureau of Ocean Energy Management, 2018. 2019-2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program.

[14] EPA. 2017. The Social Cost of Carbon. (archived)

[15] Figures in this report relate only to potential future leases in the OCS and exclude currently leased areas.

[16] BOEM estimates UERR in three primary steps. First, BOEM uses geophysical and geological information to estimate the volume of undiscovered oil and gas in a region. BOEM then estimates the portion of those volumes that could be produced using conventional extraction techniques; this volume is referred to as Undiscovered Technically Recoverable Resources (UTRR). Actual production levels will also depend on the price of oil and gas; production will not occur when the cost exceeds the price. The portion of UTRR that is commercially recoverable at specific oil and gas prices is referred to as Undiscovered Economically Recoverable Resources (UERR). As oil and gas prices increase, UERR increases. For more information, see https://www.boem.gov/sites/default/files/oil-and-gas-energy-program/Leasing/Five-Year-Program/2019-2024/DPP/NP-O-and-G-Resources-FAQ.pdf.

production level for the entire U.S. and two to six times the 2018 natural gas production level[17]. The UERR values used in this analysis are those developed by BOEM in scenarios that are based on three different levels of oil and gas prices, a major factor in estimating the economic feasibility of recovering undiscovered resources:

Low: $40/barrel for oil and $2.14/thousand cubic feet of natural gas
Medium: $100/barrel for oil and $5.34/thousand cubic feet of natural gas
High: $160/barrel for oil and $8.54/thousand cubic feet of natural gas

This analysis shows the potential CO_2e emissions and the associated SCC when all UERRs are produced and consumed in a 50-year period[18] following the issuance of leases. As the DPP goes through 2024, all issuance of leases would occur by the end of 2024 and the exploration and production is assumed to begin in 2025. The analysis further assumes that no production occurs in the first ten years[19] and that UERRs are produced and consumed at a uniform rate throughout the remaining 40 years (2035 to 2074) of the 50-year period of analysis (2025 to 2074). Total UERRs and annual production levels in unleased portions of the 22 planning areas included in the 2019-2024 DPP[20] are shown in the tables below, with estimated annual production levels.

Table III-1 Crude Oil UERRS and Annual Production, Billions of Barrels

	Low-Price Scenario	Medium-Price Scenario	High-Price Scenario
Total UERR	37.5	61.3	68.2
Annual Production, 2035-2074	0.94	1.53	1.70

Table III-2 Natural Gas UERRs and Annual Production, Trillions of Cubic Feet

	Low-Price Scenario	Medium-Price Scenario	High-Price Scenario
Total UERR	59.4	132.7	174.0
Annual Production, 2035-2074	1.48	3.32	4.35

UERRs for unleased portions of each of the 22 OCS planning areas are shown in Table VIII-1.

[17] Computations by TBD Economics, comparing the results of this analysis with those from Energy Information Administration, 2020. "Natural Gas Consumption by End Use" and "U.S. Refinery Net Input".

[18] From Bureau of Ocean Energy Management, 2018. 2019-2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program, "Production from exploration and development in newly available OCS areas will likely not occur for a decade or more, and then will continue for another 30 to 40 years or longer." This is confirmed by other sources. See, for example, Congressional Budget Office, 2016. Options for Increasing Federal Income from Crude Oil and Natural Gas on Federal Lands. This report assesses actual production statistics for leases in the Gulf of Mexico, noting that production during the first 10 years accounts for "very little of the total for wells in deep water."

[19] Ibid.

[20] BOEM 2018, op. cit.

As with BOEM's 2016 study, this report focuses only on the CO_2e emissions associated with three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The contributions of other greenhouse gases represent a negligible share of total emissions and data are not adequate for their rigorous analysis.

IV. Methodology

ASSESSING THE LIKELIHOOD OF BOEM'S PRICE-BASED SCENARIOS

As described above, the UERR scenarios from the 2019-2024 DPP, which form the basis for this analysis, are based on three oil and gas price scenarios:

Low: $40/barrel for oil and $2.14/thousand cubic feet of natural gas
Medium: $100/barrel for oil and $5.34/thousand cubic feet of natural gas
High: $160/barrel for oil and $8.54/thousand cubic feet of natural gas[21]

Historical oil prices were examined to assess the likelihood of the three price scenarios[22]. Monthly average oil prices from the spot market were obtained from the Energy Information Administration[23] and adjusted to current price levels. Between 1986[24] and 2020, 193 of the 419 adjusted monthly spot prices (46 percent) fell below $40/barrel. Another 175 (42 percent) fell between $40/barrel and $100/barrel. Only in 51 instances (12 percent) did the average monthly price fall between $100/barrel and $160/barrel. Average monthly spot prices never reached $160/barrel.

Thus, past oil prices indicate that, barring dramatic changes in the oil market, the low- and medium-price scenarios are the most likely future scenarios. The analysis reported in this document reflect the more conservative production and emission levels corresponding to the low-price scenario, with total CO_2e emissions of 19.4 billion tons. If future oil prices exceed those in the low- and medium-price scenarios, total CO_2e emissions will be even greater.

[21] BOEM estimates UERR in three primary steps: 1) BOEM uses geophysical and geological information to estimate the volume of undiscovered oil and gas in a region, 2) BOEM estimates the portion of those volumes that could be produced using conventional extraction techniques (referred to as Undiscovered Technically Recoverable Resources (UTRR)). 3) BOEM estimates portion of UTRR that is commercially recoverable at specific oil and gas prices is referred to as Undiscovered Economically Recoverable Resources (UERR). As oil and gas prices increase, UERR increases. For more information, see https://www.boem.gov/sites/default/files/oil-and-gas-energy-program/Leasing/Five-Year-Program/2019-2024/DPP/NP-O-and-G-Resources-FAQ.pdf.

[22] This comparison focused on oil prices because, under this plan, the emissions associated with crude oil are about four times greater than those associated natural gas.

[23] Energy Information Administration, 2020. Cushing, OK WTI Spot Price FOB.

[24] In the online database cited in the footnote above, the Energy Information publishes monthly spot prices from January 1986. Since this analysis extends decades into the future, the entire time series was used for this analysis. Eliminating data prior to the year 2000 yields results that continue to point to the low- and medium-cost scenarios as most likely, with only 2 percent of monthly spot prices falling into the range represented by the high-cost scenario.

ESTIMATING GREENHOUSE GAS EMISSIONS

This analysis is based on methods used in the 2016 BOEM study, to estimate the lifecycle cost of CO_2e emissions associated with three facets of oil and gas development in the OCS:

- Exploration, development, production, and transportation
- Onshore processing, storage, and distribution
- Consumption

Because SCC increases over time, production and emission values were estimated on an annual basis.

Emissions associated with exploration, development, production, and transportation. BOEM estimated the CO_2e emissions associated with exploration, development, production, and transport using their Offshore Environmental Cost Model (OECM). This model and the data were unavailable for use in this study. However, BOEM[25] found that emissions associated with exploration, development, production, and transportation amounted to no more than 2 percent of total emissions in all the scenarios that they analyzed. Because the OECM was not available for this study and because this component of total emissions was found to be small, this report applies the same proportions, estimating the portion of emissions associated with exploration, development, production, and transportation to be 2 percent of total emissions, as published in BOEM's 2016 analysis.

The results of this analysis are shown in Table VIII-2. Since production is assumed to begin in the year 2035, these values are estimated for the years 2025 to 2034.

Emissions associated with onshore processing, storage, and distribution. In this report, emissions associated with onshore processing, storage, and distribution are based on figures from EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2018 (2020), which publishes statistics for greenhouse gas emissions by type of gas and by activity. Following the example of the 2016 BOEM study, this analysis includes emissions associated with oil refining and the processing, transmission, storage, and distribution of natural gas for the for the 50-year period from 2025 to 2074. Totals for oil and gas were converted to CO_2e per unit of production using data from the Energy Information Administration on the volume of oil[26] and gas[27] used in that year, yielding the following values for emissions per unit of production (all values based on the year 2018):

Oil

[25] Bureau of Ocean Energy Management, 2016. OCS oil and Natural gas: potential lifecycle greenhouse gas emissions and social cost of carbon.

[26] Energy Information Administration, 2020. U.S. Refinery Net Input.

[27] Energy Information Administration, 2020. Natural Gas Consumption by End Use.

- Total emissions associated with refining crude oil: 4.5 million tons of CO_2e
- Total crude oil refined: 6.2 billion barrels
- Emissions per unit: 0.7 million tons of CO_2e / billion barrels of crude oil

Natural Gas

- Total emissions associated with processing, transportation, storage, and distribution: 82.9 million tons of CO_2e
- Total natural gas consumed: 30.1 trillion cubic feet
- Emissions per unit: 2.75 million tons of CO_2e / trillion cubic feet of natural gas

These unit values were applied to the estimated volume of oil and gas that would be produced under the 2019-2024 DPP over the 50-year period from 2025 to 2074.

The results of this analysis are shown in Table VIII-3. Since production is assumed to begin in the year 2035, no values are shown for earlier years.

Consumption. Crude petroleum is refined into a wide range of final products[28] whose consumption emits different volumes of CO_2e[29]. The fuel classes for which production is reported by the Energy Information Administration are not identical to those for which emissions are reported by the Environmental Protection Agency. In their 2016 report, BOEM cross walked the information from these two sources to estimate the emissions associated with the range of fuels and other products produced from crude petroleum. An examination of the more recent data[30] showing the share of products produced from crude petroleum and the emissions associated with the consumption of these fuels revealed very little change. For this reason and to maintain consistency with BOEM's 2016 analysis, this component of the analysis uses the same data as was used in the 2016 BOEM report to generate an average emission rate (392 million tons of CO_2e per billion barrels of oil) for crude petroleum that is weighted by the proportion of fuels that are produced and the emissions that correspond to those fuels.

Other chemicals are used in the refining of crude petroleum into final products and, thus, the volume of final products exceeds the volume of crude oil used to produce those products. In 2019, this "processing gain" was 6.2 percent[31]. Annual emissions resulting from the consumption of fuels produced from crude petroleum was estimated by multiplying the annual production volume by the processing gain and the weighted average emissions for the fuels produced from crude petroleum.

[28] Energy Information Administration, 2016. Petroleum Products Supplied by Type, as cited in BOEM 2016.
[29] Environmental Protection Agency, 2015. Inventory of US greenhouse gas emissions and sinks: 1990–2018, as cited in BOEM 2016.
[30] Bureau of Ocean Energy Management, 2016. OCS oil and Natural gas: potential lifecycle greenhouse gas emissions and social cost of carbon. Tables 4-1 and 4-2.
[31] Energy Information Administration, 2020. Oil and Petroleum Products Explained: Refining Crude Oil.

A similar but less complicated process was used to estimate the emissions that result from the consumption of natural gas. Natural gas emission factors used in BOEM's 2016 analysis[32] were applied to annual production volumes to estimate annual CO_2e emissions associated with the consumption of natural gas. Natural gas is not converted to other fuels prior to consumption, so there is no processing gain for natural gas.

The results of this analysis are shown in Table VIII-4. Since production is assumed to begin in the year 2035, no values are shown for earlier years. TableVIII-5 shows a summary of CO2e emissions for each of the three phases of development (1. exploration, development, production, and transportation; 2. onshore processing, storage, and distribution; and 3. consumption). Table VIII-6 shows total annual CO2e emissions for the 2019-2024 DPP, with associated exploration, production, and consumption occurring in the years 2025 to 2074.

ESTIMATING THE SOCIAL COST OF CARBON

The social cost of carbon (SCC) is a measure of the market and non-market economic damages that result from emitting one additional unit of carbon or an equivalent amount of another greenhouse gas. When carbon is released, it remains in the atmosphere for years to come. Furthermore, the losses associated with the release of carbon is a function of the concentration of atmospheric carbon, which is expected to vary over time. For these reasons, the SCC represents the sum of decades of varying effects with SCC results being sensitive to global emission and carbon concentration forecasts[33]. Losses reflected in SCC estimates capture changes in economic output, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change[34]."

Federal agencies use estimates of SCC to incorporate the societal cost of increasing CO_2e emissions and the societal benefits of reducing CO_2e emissions into economic assessments of regulatory actions. The Interagency Working Group on the Social Cost of Greenhouse Gases (IWG)[35] publishes technical guidance on the application of SCC to regulatory decision-making. The most recent guidance was issued in 2016 and states:

> *"...the Interagency Working Group (IWG) selected SC-CO_2 values for use in regulatory analyses. For each emissions year, four values are recommended. Three of these values are based on the average SC-CO_2 from three integrated assessment models (IAMs), at*

[32] Bureau of Ocean Energy Management, 2016. OCS oil and Natural gas: potential lifecycle greenhouse gas emissions and social cost of carbon. Table 4-3. Note: This table, on page 10 of the BOEM report, is mislabeled as Table 2-3.

[33] Price, R., Thornton, S. and Nelson, S., 2007. The social cost of carbon and the shadow price of carbon: what they are, and how to use them in economic appraisal in the UK.

[34] Interagency Working Group on Social Cost of Greenhouse Gases, United States Government, 2016. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis-Under Executive Order 12866. Environmental Protection Agency.

[35] Formerly, the Interagency Working Group on the Social Cost of Carbon.

discount rates of 2.5, 3, and 5 percent. In addition, … there is extensive evidence in the scientific and economic literature on the potential for lower-probability, but higher-impact outcomes from climate change, which would be particularly harmful to society and thus relevant to the public and policymakers. The fourth value is thus included to represent the marginal damages associated with these lower-probability, higher-impact outcomes. Accordingly, this fourth value is selected from further out in the tail of the distribution of SC-CO_2 estimates; specifically, the fourth value corresponds to the 95th percentile of the frequency distribution of SC-CO_2 estimates based on a 3 percent discount rate. [36]*."*

The SCC values published by the IWG represent averages from the most recent (as of 2016) results of four integrated assessment models (DICE, PAGE, and FUND[37]); values in the 2016 IWG report are presented at 2007 price levels. Selected values (five-year intervals) are shown in Table IV-1; the full list of published values (annual) is presented in Table VIII-7.

Table IV-1 2016 Social Cost of Carbon Values (in USD 2007 per metric ton)

Year	5%	3%	2.50%	High Impact
2020	$12.00	$32.00	$62.00	$123.00
2025	$14.00	$46.00	$68.00	$138.00
2030	$16.00	$50.00	$73.00	$152.00
2035	$18.00	$55.00	$78.00	$168.00
2040	$21.00	$60.00	$84.00	$183.00
2045	$23.00	$64.00	$89.00	$197.00
2050	$26.00	$69.00	$95.00	$212.00

For use in this study, these values were updated to January 2020 price levels using the GDP Implicit Price Deflator, with selected values shown in Table IV-2.

Table IV-2 2016 Social Cost of Carbon Values (in USD 2020 per metric ton)

Year	5%	3%	2.50%	High Impact
2020	$14.84	$39.57	$76.68	$152.11
2025	$17.31	$56.89	$84.10	$170.66
2030	$19.79	$61.83	$90.28	$187.98

[36] Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. 2016.
[37] The DICE (Dynamic Integrated Climate and Economy) model by William Nordhaus evolved from a series of energy models and was first presented in 1990 (Nordhaus and Boyer 2000). The PAGE (Policy Analysis of the Greenhouse Effect) model was developed by Chris Hope in 1991 for use by European decision-makers in assessing the marginal impact of carbon emissions (Hope 2006). The FUND (Climate Framework for Uncertainty, Negotiation, and Distribution) model, developed by Richard Tol in the early 1990s, originally to study international capital transfers in climate policy, is now widely used to study climate impacts (e.g., Tol 2002a, Tol 2002b, Anthoff et al. 2009, Tol 2009).

2035	$22.26	$68.02	$96.46	$207.77
2040	$25.97	$74.20	$103.88	$226.32
2045	$28.44	$79.15	$110.07	$243.63
2050	$32.15	$85.33	$117.49	$262.18

No SCC values were published for use in years beyond 2050. Each year between 2040 and 2050, published SCC values increase from $0.50 to $1.00 per ton of CO2e, reflecting increasing atmospheric CO2e levels (increasing the physical effects of climate change) and global wealth (increasing the associated economic losses. For the years 2051 to 2074 (the end of the 50-year period of analysis), SCC values were extrapolated at the more conservative rate of $0.50 per ton of CO2e annually.

Annual SCC ($/metric ton) values in Table IV-2 (above) were applied to annual carbon emission values (metric tons) to calculate the annual social cost of the carbon that would be released under the 2019 to 2024 DPP.

Then, the stream of annual costs was discounted to calculate its present value. For each of the four sets of SCC values, the present value of SCC was computed using the same discount rates that were used in SCC computations. A summary of these results is presented in Table IV-3 below.

Table IV-3 Present Value of SCC, Billions of 2020 Dollars

	SCC, 5%	SCC, 3%	SCC, 2.5%	SCC, High Impact
Low Oil/Gas Price Scenario	$168	$723	$1,131	$2,166
Medium Oil/Gas Price Scenario	$286	$1,235	$1,934	$3,698
High Oil/Gas Price Scenario	$331	$1,428	$2,237	$4,278

The broad range in these present value estimates is in part due to uncertainty about future economic conditions (reflected in different discount rates) and the appropriate level of risk-taking with regard to climate policy (reflected in SCC values associated with low-probability, high-impact outcomes).

V. Results

The 2019-2024 DPP encompasses all 22 planning regions comprising the OCS. This analysis finds that the development of these areas and the production and consumption of the crude oil and natural gas located in the currently unleased portions of this area would result in greenhouse gas emissions ranging from 19.4 billion tons to 39.2 billion tons of CO_2e between 2025 and 2074, depending on future prices of oil and gas. Estimated CO_2e emissions associated with each of the three facets of oil and gas development are shown in Table V-1.

Table V-1 Estimated CO_2e Emissions, Millions of Tons

	Oil and Gas Price Scenario		
	Low	**Medium**	**High**
Exploration, development, production, and transportation	388.8	677.0	783.8
Onshore processing, storage, and distribution	190.5	409.5	528.2
Consumption	18,859.3	32,758.7	37,872.4
Total	19,438.6	33,845.2	39,184.4

CO_2e emissions are directly proportional to production levels. Total CO_2e emissions associated with the 2019-2024 DPP were disaggregated to the 22 planning regions based on UERRs in each region. These results, shown for the low price of oil and gas scenario, are shown in Table V-2.

Table V-2 Emissions by Planning Region, Millions of Tons of CO_2e (MMt CO_2e), Low-Price Scenario

Region	MMt CO_2e	Percent of Total
Central Gulf of Mexico (GOM)	8,861.8	45.6%
Western GOM	3,899.0	20.1%
Eastern GOM	1,399.5	7.2%
Southern California	1,241.7	6.4%
Mid-Atlantic	938.4	4.8%
Central California	780.6	4.0%
North Atlantic	776.6	4.0%
Beaufort Sea	457.0	2.4%
Northern California	400.4	2.1%
Cook Inlet	351.9	1.8%
North Aleutian Basin	141.6	0.7%
Washington/Oregon	89.0	0.5%
South Atlantic	52.6	0.3%
Chukchi Sea	32.4	0.2%
St. George Basin	8.1	0.0%
Hope Basin	4.0	0.0%
Straits of Florida	4.0	0.0%
Gulf of Alaska	0.0	0.0%
Navarin Basin	0.0	0.0%
Kodiak	0.0	0.0%
Norton Basin	0.0	0.0%
Shumagin	0.0	0.0%
Total	19,438.6	100.0%

The data used in this analysis allowed the estimation of CO_2e emissions for each type of greenhouse gas emitted. As shown in Table V-3, CO_2 accounts for most emissions.

Table V-3 Estimated CO_2e Emissions by Source, Millions of Tons, Low-Price Scenario

	Million tons of CO_2e	Percent of Total
CO_2	19,083	98 %
CH_4	12	>1 %
NO_2	344	2 %
Total	19,438	100%

VI. Conclusions

Implementing the 2019-2024 DPP comes at high environmental, social, and economic costs. In 2018, the total CO_2e emissions in the United States from all sources were 6.7 billion tons[38]. Under the low-price of oil/gas scenario ($40/barrel), CO_2e potential emissions associated with developing the 47 lease sales proposed in the 2019-2024 DPP are over 19 billion tons over the lifetime of the leases. That is equivalent to almost 3 years of CO_2e emissions for the United States from all sources at 2018 levels. If oil prices rise to $100/barrel the emissions from the 2019-2024 DPP would equal 5 times the total CO_2e emissions in 2018, and 6 times with the high-price scenario of $160/barrel.

The CO_2e emissions from developing all OCS leases in the 2019-2024 DPP would result in $723 billion in economic damages under the low-price scenario over fifty years at a 3 percent discount rate. That is larger than the entire U.S. Ocean Economy in 2018. For comparison, this figure exceeds the annual GDP of 44 out of 50 U.S. states in 2018[39], is about the same as the 2018 GDP for the Chicago metropolitan area[40], and is more than the annual GDP of major cities such as Washington, Dallas/Fort Worth, Boston, Atlanta, Seattle, and Miami (See Figure VI-1).

Under the medium-price scenario, only Florida, Texas, and California's annual GDP exceed the social costs of this leasing program, which would be over $1.2 trillion. This is greater than the 2018 GDP for the Los Angeles metropolitan area—the second largest metropolitan area in the country, measured in terms of GDP. It is important to note that the figures in this report are based on values that were selected from the lower half of the ranges published for both the SCC and the volume of oil and gas that will be produced and consumed; thus, the true cost of implementing the 2019-2024 DPP could be significantly higher.

Figure VI-1 compares the SCC associated with the 2019-2024 DPP with the 2018 GDP of the nation's twelve largest Metropolitan Statistical Areas[41].

For further comparison, annual CO2e emissions associated with the 2019-2024 DPP equal the annual emissions from 4.2 billion typical passenger cars in the low-price scenario and 7.4 billion passenger cars under the medium-price scenario. In 2018, about 250 million passenger cars were registered in the U.S. Thus, full implementation of the 2019-2024 DPP will lead to CO_2e

[38] Environmental Protection Agency, 2020. Inventory of US greenhouse gas emissions and sinks: 1990–2018.
[39] Bureau of Economic Analysis, 2020. Regional Economic Accounts.
[40] GDP in the three largest Metropolitan Statistical Area (MSA) economies in the United States, New York, Los Angeles, and Chicago exceeds that of 44 of the 50 states.
[41] Bureau of Economic Analysis, 2020, Regional Data.

emissions equal to the operation of all passenger cars in the U.S. for about 15 years under the low-price scenario, and about 30 years under the medium-price scenario [42,43,44].

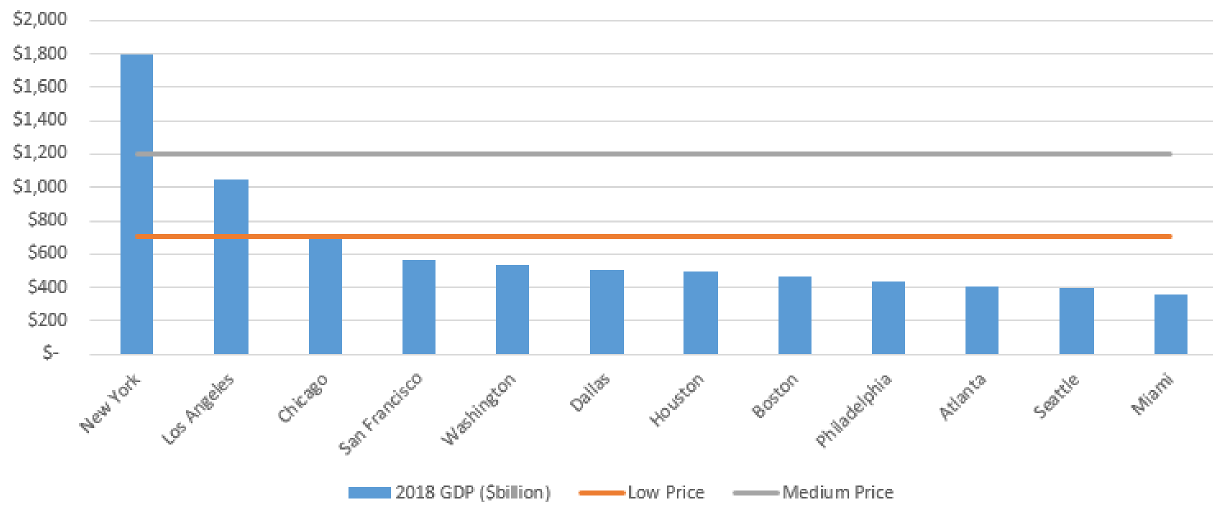

Figure VI-1 2019 - 2024 DPP, Social Cost of Carbon Compared to Annual GDP of the Largest Metropolitan Statistical Areas

Our oceans provide a wealth of benefits to the United States, sustaining more than 3 million jobs and contributing more than $300 billion to the U.S. economy in 2018[45]. Nearly 49 million U.S adults visited the oceans and coasts in 2012[46], looking for clean beaches and healthy waters. The oil and gas development associated with the lease sales from the 2019-2024 DPP would put these jobs and this economic value at risk and generate additional costs associated with other forms of economic output, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change, with a total cost of $723 billion or more.

[42] The Environmental Protection Agency's "Green Vehicle Guide" states that "[a] typical passenger vehicle emits about 4.6 metric tons of carbon dioxide per year."
[43] Bureau of Transportation Statistics. Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances. 2020.
[44] Sample computation. The low-price scenario would lead to CO_2e emissions of 19,438 million tons. The typical passenger car emits 4.6 tons of CO_2e annually. 19,438 million tons of CO_2e / 4.6 tons per car = 4.2 billion cars (annual emissions). 4,226 million cars / 250 million cars per year = 16.8 years.
[45] NOAA Report on the U.S. Marine Economy. 2020
[46] NOAA, 2018. National Ocean Recreation Expenditure Survey. https://spo.nmfs.noaa.gov/sites/default/files/TMSPO185_REV.pdf accessed December 21, 2020.

VII. References

Bureau of Economic Analysis, 2020. Regional Data. Available online at https://apps.bea.gov/itable/iTable.cfm?ReqID=70&step=1. Accessed December 30, 2020.

Bureau of Economic Analysis, 2020. Regional Economic Accounts: Download. Available online at https://apps.bea.gov/regional/downloadzip.cfm. Accessed December 16, 2020.

Bureau of Ocean Energy Management, 2018. 2019-2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program.

Bureau of Ocean Energy Management, 2016. OCS oil and Natural gas: potential lifecycle greenhouse gas emissions and social cost of carbon.

Bureau of Transportation Statistics. 2020. Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances. Available online at https://www.bts.gov/content/number-us-aircraft-vehicles-vessels-and-other-conveyances. Accessed December 30, 2020.

Congressional Budget Office, 2016. Options for Increasing Federal Income from Crude Oil and Natural Gas on Federal Lands. Available online at https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/reports/51421-oil_and_gas_options.pdf. Accessed December 16, 2020.

Energy Information Administration, 2020. U.S. Refinery Net Input. Available online at https://www.eia.gov/dnav/pet/pet_pnp_inpt2_dc_nus_mbbl_a.htm. Accessed December 16, 2020.

Energy Information Administration, 2020. Cushing, OK WTI Spot Price FOB. Available online at https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RWTC&f=M. Accessed December 16, 2020.

Energy Information Administration, 2020. Natural Gas Consumption by End Use. Available online at https://www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm. Accessed December 16, 2020.

Energy Information Administration, 2020. Oil and Petroleum Products Explained: Refining Crude Oil. Available online at https://www.eia.gov/energyexplained/oil-and-petroleum-products/refining-crude-oil-inputs-and-outputs.php. Accessed December 16, 2020.

Energy Information Administration, 2016. Petroleum Products Supplied by Type, as cited in BOEM 2016.

Environmental Protection Agency, 2020. Emission factors for greenhouse gas inventories. Available online at https://www.epa.gov/sites/production/files/2020-04/ghg-emission-factors-hub.xlsx. Accessed December 16, 2020.

Environmental Protection Agency, 2020. Greenhouse Gas Emissions from a Typical Passenger Vehicle. Available online at https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle. Accessed December 16, 2020.

Environmental Protection Agency, 2020. Inventory of US greenhouse gas emissions and sinks: 1990–2018.

Environmental Protection Agency, 2017. The Social Cost of Carbon: Estimating the Benefits of Reducing Greenhouse Gas Emissions (archived). Available online at https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html. Accessed January 21, 2021.

Environmental Protection Agency, 2015. Inventory of US greenhouse gas emissions and sinks: 1990–2018, as cited in BOEM 2016.Hope, C., 2006. The marginal impact of CO_2 from PAGE2002: An integrated assessment model incorporating the IPCC's five reasons for concern. Integrated assessment, 6(1).

Interagency Working Group on Social Cost of Greenhouse Gases, 2013. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis-Under Executive Order 12866. Environmental Protection Agency.

Millar, R.J., Fuglestvedt, J.S., Friedlingstein, P., Rogelj, J., Grubb, M.J., Matthews, H.D., Skeie, R.B., Forster, P.M., Frame, D.J. and Allen, M.R., 2017. Emission budgets and pathways consistent with limiting warming to 1.5 C. Nature Geoscience, 10(10), pp.741-747.

National Oceanic and Atmospheric Administration (NOAA), Office for Coastal Management. 2020. NOAA Report on the U.S. Marine Economy. Available at https://coast.noaa.gov/data/digitalcoast/pdf/econ-report.pdf.

Nordhaus, W.D. and Boyer, J., 2000. Warming the world: economic models of global warming. MIT press.

Plains CO_2 Reduction Partnership, 2020. Global Carbon Cycle. Available online at https://undeerc.org/pcor/sequestration/cycle.aspx. Accessed December 16, 2020.

Price, R., Thornton, S. and Nelson, S., 2007. The social cost of carbon and the shadow price of carbon: what they are, and how to use them in economic appraisal in the UK.

Tol, R.S., 2002. Estimates of the damage costs of climate change. Part 1: Benchmark estimates. Environmental and resource Economics, 21(1), pp.47-73.

Tol, R.S., 2002. Estimates of the damage costs of climate change, Part II. Dynamic estimates. Environmental and Resource Economics, 21(2), pp.135-160.

VIII. Additional Tables

Table VIII-1 Undiscovered Economically Recoverable Resources by OCS Planning Region (Unleased areas, only)

No.	Planning Area	Oil (Bbo)			Gas (Tcf)		
		$40/bbl, $2.14/mcf	$100/bbl, $5.34/mcf	$160/bbl, $8.54/mcf	$40/bbl, $2.14/mcf	$100/bbl, $5.34/mcf	$160/bbl, $8.54/mcf
1	Central GOM	17.2	20.99	21.90	26.46	43.95	49.49
2	Chukchi Sea	0.07	9.25	12.61	0.06	22.58	40.63
3	Western GOM	6.99	8.69	9.10	14.91	25.68	28.76
4	Beaufort Sea	1.02	6.06	7.07	0.66	8.07	12.61
5	Southern California	2.45	3.58	3.87	3.47	4.84	5.26
6	Eastern GOM	2.55	3.06	3.19	5.14	6.91	7.65
7	Mid-Atlantic	1.89	2.18	2.25	2.41	7.42	10.29
8	North Atlantic	1.48	1.64	1.68	2.45	5.05	6.24
9	Central California	1.63	2.08	2.18	1.71	2.17	2.27
10	Northern California	0.83	1.34	1.50	0.91	1.52	1.77
11	Cook Inlet	0.81	0.98	1.00	0.33	0.77	1.03
12	Gulf of Alaska	0.00	0.31	0.47	0.01	1.62	2.73
13	North Aleutian Basin	0.33	0.51	0.55	0.13	0.34	0.86
14	Washington/Oregon	0.14	0.23	0.26	0.46	0.79	0.93
15	South Atlantic	0.09	0.18	0.22	0.20	0.52	0.69
16	St. George Basin	0.02	0.10	0.13	0.02	0.15	0.66
17	Hope Basin	0.01	0.06	0.08	0.02	0.17	0.9
18	Navarin Basin	0.00	0.05	0.07	0.00	0.12	0.30
19	Straits of Florida	0.01	0.01	0.01	0.01	0.01	0.01
20	Kodiak	0.00	0.00	0.02	0.00	0.02	0.54
21	Norton Basin	0.00	0.00	0.01	0.00	0.00	0.40
22	Shumagin	0.00	0.00	0.00	0.00	0.00	0.02
Total		37.52	61.30	68.17	59.36	132.70	174.04

Source: Bureau of Ocean Energy Management, 2018. 2019-2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program. Table 5-1.

Notes: Bbo= billion barrels of oil; bbl=barrels of oil, mcf=thousand cubic feet of natural gas, Tcf=trillion cubic feet of natural gas, UERR=undiscovered economically recoverable resources.

Table VIII-2 Emissions associated with exploration, development, production, and transportation, million tons of CO_2e

	Oil MMT CO_2e			Natural Gas MMT CO_2e			Oil and Natural Gas MMT CO_2e		
	$40/bbl,	$100/bbl,	$160/bbl,	$40/bbl,	$100/bbl,	$160/bbl,	Low	Medium	High
Year	$2.14/mcf	$5.34/mcf	$8.54/mcf	$2.14/mcf	$5.34/mcf	$8.54/mcf			
2025	31.9	52.2	58.0	6.9	15.5	20.3	38.9	67.7	78.4
2026	31.9	52.2	58.0	6.9	15.5	20.3	38.9	67.7	78.4
2027	31.9	52.2	58.0	6.9	15.5	20.3	38.9	67.7	78.4
2028	31.9	52.2	58.0	6.9	15.5	20.3	38.9	67.7	78.4
2029	31.9	52.2	58.0	6.9	15.5	20.3	38.9	67.7	78.4
2030	31.9	52.2	58.0	6.9	15.5	20.3	38.9	67.7	78.4
2031	31.9	52.2	58.0	6.9	15.5	20.3	38.9	67.7	78.4
2032	31.9	52.2	58.0	6.9	15.5	20.3	38.9	67.7	78.4
2033	31.9	52.2	58.0	6.9	15.5	20.3	38.9	67.7	78.4
2034	31.9	52.2	58.0	6.9	15.5	20.3	38.9	67.7	78.4
Total	319.5	521.9	580.4	69.4	155.0	203.3	388.8	677.0	783.8

Table VIII-3 Emissions associated with onshore processing, storage, and distribution of oil and natural gas, million tons of CO_2e (MMT CO_2e)

	Oil MMT CO_2e			Natural Gas MMT CO_2e			Oil and Natural Gas MMT CO_2e		
Year	$40/bbl, $2.14/mcf	$100/bbl, $5.34/mcf	$160/bbl, $8.54/mcf	$40/bbl, $2.14/mcf	$100/bbl, $5.34/mcf	$160/bbl, $8.54/mcf	$40/bbl, $2.14/mcf	$100/bbl, $5.34/mcf	$160/bbl, $8.54/mcf
2035	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2036	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2037	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2038	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2039	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2040	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2041	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2042	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2043	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2044	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2045	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2046	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2047	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2048	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2049	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2050	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2051	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2052	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2053	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2054	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2055	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2056	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2057	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2058	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2059	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2060	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2061	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2062	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2063	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2064	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2065	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2066	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2067	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2068	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2069	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2070	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2071	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2072	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2073	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
2074	0.7	1.1	1.2	4.1	9.1	12.0	4.8	10.2	13.2
Total	27.3	44.5	49.5	163.3	365.0	478.7	190.5	409.5	528.2

Notes: bbl=barrels of oil, mcf=thousand cubic feet of natural gas.

Table VIII-4 Emissions associated with the consumption of petroleum products and natural gas, million tons of CO_2e (MMT CO_2e)

Year	Oil MMT CO_2e			Natural Gas MMT CO_2e			Oil and Natural Gas MMT CO_2e		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
2035	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2036	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2037	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2038	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2039	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2040	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2041	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2042	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2043	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2044	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2045	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2046	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2047	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2048	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2049	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2050	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2051	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2052	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2053	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2054	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2055	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2056	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2057	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2058	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2059	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2060	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2061	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2062	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2063	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2064	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2065	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2066	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2067	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2068	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2069	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2070	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2071	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2072	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2073	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
2074	390.6	638.2	709.7	80.9	180.8	237.1	471.5	819.0	946.8
Total	15,624.4	25,527.1	28,388.0	3,234.9	7,231.6	9,484.4	18,859.3	32,758.7	37,872.4

Table VIII-5 Summary of emissions by phases of development, million tons of CO_2e (MMT CO_2e)

	Oil MMT CO_2e			Natural Gas MMT CO_2e			Oil and Natural Gas MMT CO_2e		
	Low	**Medium**	**High**	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
Exploration, development, production, and transportation	319.5	521.9	580.4	69.4	155.0	203.3	388.8	677.0	783.8
Onshore processing, storage, and distribution	27.3	44.5	49.5	163.3	365.0	478.7	190.5	409.5	528.2
Consumption	15,624.4	25,527.1	28,388.0	3,234.9	7,231.6	9,484.4	18,859.3	32,758.7	37,872.4
Total	15,971.1	26,093.6	29,017.9	3,467.5	7,751.6	10,166.5	19,438.6	33,845.2	39,184.4

Table VIII-6 Annual emissions, million tons of CO_2e (MMT CO_2e)

	Oil MMT CO_2e			Natural Gas MMT CO_2e			Oil and Natural Gas MMT CO_2e		
Year	Low	Medium	High	Low	Medium	High	Low	Medium	High
2025	14.6	17.9	18.6	3.1	5.1	5.8	17.7	23.0	24.4
2026	14.6	17.9	18.6	3.1	5.1	5.8	17.7	23.0	24.4
2027	14.6	17.9	18.6	3.1	5.1	5.8	17.7	23.0	24.4
2028	14.6	17.9	18.6	3.1	5.1	5.8	17.7	23.0	24.4
2029	14.6	17.9	18.6	3.1	5.1	5.8	17.7	23.0	24.4
2030	14.6	17.9	18.6	3.1	5.1	5.8	17.7	23.0	24.4
2031	14.6	17.9	18.6	3.1	5.1	5.8	17.7	23.0	24.4
2032	14.6	17.9	18.6	3.1	5.1	5.8	17.7	23.0	24.4
2033	14.6	17.9	18.6	3.1	5.1	5.8	17.7	23.0	24.4
2034	14.6	17.9	18.6	3.1	5.1	5.8	17.7	23.0	24.4
2035	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2036	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2037	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2038	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2039	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2040	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2041	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2042	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2043	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2044	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2045	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2046	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2047	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2048	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2049	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2050	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2051	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2052	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2053	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2054	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2055	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2056	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2057	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2058	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2059	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2060	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2061	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2062	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2063	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2064	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2065	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2066	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2067	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2068	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2069	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2070	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2071	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2072	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2073	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
2074	391.3	639.3	710.9	85.0	189.9	249.1	476.2	829.2	960.0
Total	15,971.1	26,093.6	29,017.9	3,467.5	7,751.6	10,166.5	19,438.6	33,845.2	39,184.4

Table VIII-7 Annual SC-CO_2 Values: 2010-2050 (2007$/metric ton CO_2e)

Year	5%	3%	2.5%	High Impact
2020	12	42	62	123
2021	12	42	63	126
2022	13	43	64	129
2023	13	44	65	132
2024	13	45	66	135
2025	14	46	68	138
2026	14	47	69	141
2027	15	48	70	143
2028	15	49	71	146
2029	15	49	72	149
2030	16	50	73	152
2031	16	51	74	155
2032	17	52	75	158
2033	17	53	76	161
2034	18	54	77	164
2035	18	55	78	168
2036	19	56	79	171
2037	19	57	81	174
2038	20	58	82	177
2039	20	59	83	180
2040	21	60	84	183
2041	21	61	85	186
2042	22	61	86	189
2043	22	62	87	192
2044	23	63	88	194
2045	23	64	89	197
2046	24	65	90	200
2047	24	66	92	203
2048	25	67	93	206
2049	25	68	94	209
2050	26	69	95	212