Options for Incorporating the Social Cost of Greenhouse Gas Emissions

Bureau of Ocean Energy Management
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I. Introduction

The Bureau of Ocean Energy Management (BOEM) assessed options to account for the social costs of emissions of greenhouse gases (SC-GHG) during oil and gas activities as directed by Section 208 of Executive Order (E.O.) 14008[1]:

> *[T]he Secretary of the Interior shall consider whether to adjust royalties associated with coal, oil, and gas resources extracted from public lands and offshore waters, or take other appropriate action, to account for corresponding climate costs.*

The purpose of incorporating the SC-GHG is to provide a mechanism that allows the social value of greenhouse gas emissions to factor into operators' decision-making by requiring them to pay for the cost of their emissions. In the context of oil and gas development, reductions in GHG emissions can be achieved by either implementing emissions abatement technologies (such as carbon capture and sequestration) or by incentivizing operators to reduce oil and gas activities and production, given that the return on investment is lower after accounting for GHG externalities.

This paper outlines the analysis conducted to determine an appropriate royalty rate surcharge to incorporate the SC-GHG into the royalty companies are required to pay.

II. Outer Continental Shelf (OCS) and GHG Emissions

BOEM conducts an OCS emissions inventory every three years and reports sources and volumes for National Ambient Air Quality Standards (NAAQS) and precursor air pollutants and greenhouse gases. BOEM's Year 2017 Emissions Inventory Study, the sixth Gulf of Mexico (GOM) OCS emissions inventory developed by BOEM since 2000, reports the emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) arising from GOM oil and gas activities during calendar year 2017.[2,3] Table 1 shows the 2017 estimates of the emissions arising from various categories of oil and gas exploration and development activities.

[1] Executive Order on Tackling the Climate Crisis at Home and Abroad.
[2] Year 2017 Emissions Inventory Study. The 2017 OCS Emissions Inventory study reports emissions in short tons. For the purpose of these calculations, emissions have been converted to metric tons [1 metric ton = 1.10231 short ton] since the SC-GHG figures are in metric tons.
[3] At the time of this analysis the 2017 Emissions Inventory Study is BOEM's most recent GOM emissions inventory.

Table 1: GOM 2017 Upstream Oil and Gas Greenhouse Gas Emissions

Source Category	CO_2 Emissions (mtpy)	CH_4 Emissions (mtpy)	N_2O Emissions (mtpy)	CO_2e Emissions (mtpy)
Platform Emissions	6,220,892	170,455	107	10,514,219
Drilling Rigs	461,573	3	24	468,533
Pipelaying Operations	173,392	1	8	175,834
Support Helicopters	47,102	1	2	47,590
Support Vessels	2,006,437	8	122	2,042,813
Survey Vessels	245,010	1	14	249,186
Total OCS oil and gas emissions	**9,154,406**	**170,468**	**276**	**13,498,176**

mtpy = metric tons per year; CO_2e = carbon dioxide equivalent

The SC-GHG is estimated using the upstream GHG emissions and the costs of those emissions. In 2021, the United States Government Interagency Working Group on Social Cost of Greenhouse Gases (IWG) produced an interim report that reaffirmed the 2016 SC-GHG estimates for each of the three greenhouse gases.[4] BOEM converted the IWG SC-GHG estimates into CO_2 equivalents.[5] In its 2021 interim report, the IWG provided estimates of the social cost of one metric ton of pollutant emitted for 2020 and various future years. Because the impacts of greenhouse gases depend on the baseline level of emissions in the environment, the social cost of a given amount of emissions becomes more costly in the future. The 2020 CO_2 social cost is $53 per metric ton, CH_4 is priced at $1,551 per metric ton, and N_2O is priced at $18,612 per metric ton.[6] The social costs in 2035 are projected to increase significantly to $69 per metric ton of CO_2, $2,275 per metric ton of CH_4, and $25,850 per metric ton of N_2O.

The 2021 IWG interim report calculates different measures of the SC-GHG for each year from 2020 through 2050 using three different discount rates: 2.5%, 3%, and 5%. A lower discount rate results in higher estimated social costs because future impacts are given more weight in the calculation. BOEM uses a 3% social discount rate in most of its analyses (which is based on the Office of Management and Budget's recommendation). Therefore, in this paper, BOEM used the SC-GHG values based on a 3% discount rate, although BOEM has the ability to perform similar calculations using a 2.5% or 5% discount rate.

Table 2 displays the social cost of greenhouse gases arising from 2017 upstream GOM activities using the 2020 SC-GHG values; the total cost is $752.3 million (2021$). If the social costs were instead calculated using the 2035 SC-GHG values, the total social cost of the emissions would increase to $1.03 billion (2021$).

[4] Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide.
[5] The CO_2 equivalent (CO_2e) levels are based on the global warming potential of CO_2 under a 20-year time horizon. CH_4 has 25 times and N_2O has 298 times the global warming potential of CO_2.
[6] All dollar values in this paper are presented in 2021 dollars. The costs in the IWG report are $51 for CO_2, $1,500 for CH_4, and $18,000 for N_2O in 2020 dollars, but have been inflated to 2021 dollars using the Federal Reserve inflator of 1.034.

Table 2: Social Cost of GOM's 2017 Upstream Greenhouse Gas Emissions (2021$)

Source Category	CO_2 Social Cost	CH_4 Social Cost	N_2O Social Cost	Total SC-GHG
Platform Emissions	$328,052,519	$264,375,705	$1,991,484	$594,419,708
Drilling Rigs	$24,340,591	$4,653	$446,688	$24,791,932
Pipelaying Operations	$9,143,654	$1,551	$148,896	$9,294,101
Support Helicopters	$2,483,877	$1,551	$37,224	$2,522,652
Support Vessels	$105,807,449	$12,408	$2,270,664	$108,090,521
Survey Vessels	$12,920,357	$1,551	$260,568	$13,182,476
Total OCS oil and gas SC-GHG	**$482,748,446**	**$264,397,419**	**$5,155,524**	**$752,301,389**

III. Methodology for Incorporating a Royalty Rate Surcharge

To incorporate the SC-GHG into the royalty rate, BOEM would need to add the calculated royalty surcharge to the appropriate royalty rate that would have been selected. For example, in recent sales the deepwater royalty rate of 18.75% would be increased by a constant percentage to approximate the SC-GHG. This would require companies to pay for the GHG emissions of development. At the margin, the surcharge could potentially lead to a reduction in emissions as the higher royalty rate would lessen the incentives for oil and gas development. For example, a royalty rate surcharge could cause operators to choose to not lease certain tracts and potentially conduct less exploration activities as the royalty surcharge leads to a reduced upside to exploration. In addition, since the cost of production increases with the royalty surcharge, some marginal projects may not be undertaken due to no longer being economic, resulting in reduced upstream emissions. For all production that continues, lessees would be required to pay the higher royalty rate, thus compensating the government for the increased emissions associated with development.

A royalty surcharge would not provide a direct incentive to reduce GHG emissions. Typically, the SC-GHG is designed to encourage companies to reduce emissions by forcing them to pay for their emissions (and associated damages) or employ emission abatement technologies. However, a royalty surcharge is locked into the royalty for the duration of the lease and thus does not provide incentives to reduce emissions on a per-BOE basis, although it could still reduce emissions by lessening the incentives for oil and gas production. However, it does require lessees to pay the government to compensate for a proportional share of all development emissions.

Using the emissions estimates and social costs associated with the emissions in Table 1 and Table 2, BOEM calculated a per-BOE emission cost using 2017 marketed oil and gas production. Table 3 shows the amount of OCS oil, gas, and BOE produced and marketed in 2017. Table 4 shows BOEM's estimates of the per-BOE SC-GHG arising from this production using both the 2020 and 2035 estimates of SC-GHG.

Table 3: 2017 Marketed Oil and Gas Production

Oil/Gas Category	2017 Marketed Oil and Gas Production[7]
Oil Production (barrels)	613,376,753
Gas Production (Mcf)	786,205,914
Barrels of Oil Equivalent (BOE)*	753,271,044

*Natural gas to BOE conversion: 1 BOE = 5.62 mcf

Table 4: Estimated Social Costs (2021$)

	2020 IWG	2035 IWG
Estimated Emission Social Cost per BOE	$1.00	$1.37

Using the 2020 SC-GHG, each BOE produced in 2017 was responsible for an estimated $1.00 in social costs. Extrapolating this into the future, if relative emissions remained the same, each BOE in 2035 would be responsible for approximately $1.37 in social costs. Using the 2035 estimate may be more appropriate because this analysis will be used to value emissions from future leases that will not begin production for many years.

To convert this BOE social cost into a royalty surcharge (which is a percentage), BOEM must make assumptions about future oil and gas prices. Figure 1 shows the formula used to estimate the royalty rate surcharge given assumptions about future oil and natural gas prices.

Figure 1: Calculation of Royalty Rate Surcharge

$$\text{Royalty Rate Surcharge} = \frac{\text{Total Social Cost of GHG Emissions from OCS Oil and Gas Activities}}{(\text{oil production x price of oil}) + (\text{gas production x price of gas})}$$

With a fixed percentage point royalty surcharge, as oil and gas prices increase, the revenues collected for the GHG emissions increase on a per-unit basis because the percentage is charged on a larger value for the same amount of production. Given the volatility of commodity prices, fluctuations in future emissions levels, and uncertainty in social cost estimates, a royalty surcharge would not be a perfect solution but could serve as a reasonable proxy for the social cost of upstream emissions.

Table 5 uses the 2020 IWG estimate of the SC-GHG to calculate the range of possible royalty surcharges for various possible pairs of oil and gas prices. Table 6 uses the 2035 IWG estimate of the SC-GHG to estimate the range of royalty surcharges. In both tables, the computed royalty surcharge varies notably depending on the assumptions one makes about oil and gas prices; the higher the assumed oil and gas prices, the lower the appropriate royalty surcharge. Using the 2020-SC-GHG and BOEM's estimate of 2021 oil and gas prices (in 2021 dollars of $60.5 per

[7] Marketed production is the amount of production that is sold to market. Marketed production equals actual production minus losses, flared production, and any production used on location to generate power for operations. Royalties are based on marketed production. Emissions are based on actual production. The royalty rate surcharge accounts for emissions on non-marketed production and adds those costs to royalties on marketed production.

barrel of oil and $2.75 per mcf of natural gas)[8], the royalty surcharge would be 1.9 percentage points. Using the 2035 SC-GHG and BOEM's 2035 estimate of oil and gas prices (in 2021 dollars of $65.5 per barrel and $3.54 per mcf), the royalty surcharge would be 2.4 percentage points.

Table 5: Illustrative SC-GHG Range of Royalty Surcharge Using 2020 SC-GHG

$ per mcf \ $ per bbl (2021 dollars)	$40	$60	$80	$100
$2	2.88%	1.96%	1.49%	1.20%
$3	2.80%	1.92%	1.46%	1.18%
$4	2.72%	1.88%	1.44%	1.17%
$5	2.64%	1.85%	1.42%	1.15%

Table 6: Illustrative SC-GHG Range of Royalty Surcharge using 2035 SC-GHG

$ per mcf \ $ per bbl (2021 dollars)	$40	$60	$80	$100
$2	3.94%	2.68%	2.03%	1.64%
$3	3.83%	2.63%	2.00%	1.62%
$4	3.72%	2.58%	1.97%	1.60%
$5	3.62%	2.53%	1.94%	1.58%

At this stage, BOEM believes that a royalty surcharge of around 2.25 percent is likely appropriate. This corresponds to a 30%/70% weighted average of the royalty surcharges using the 2020 and 2035 SC-GHG along with BOEM's price forecast. Giving the 2035 estimate more weight is reasonable given that oil and gas production will not occur for several years after the lease is issued. However, changes in regulations and improvements in technology could cause emissions rates to decline over time. Therefore, assigning some weight (although less than the 2035 weight) to the 2020 estimate so as not to set the royalty surcharge too high is appropriate. In addition, BOEM's price forecasts may increase in the future, which would result in a lower appropriate royalty surcharge than currently suggested by the 2035 numbers. There is substantial variability and uncertainty associated with many of the parameters under consideration (such as future emissions rates, the SC-GHG, oil/gas prices, and the appropriate discount rate). Therefore, BOEM would reassess the appropriate royalty surcharge as new information becomes available. For example, BOEM's emissions inventory is updated every three years. However, any changes to the royalty rate surcharge would only apply to leases issued from that time forward.

A royalty surcharge would generate revenues only from producing leases. While leases that simply explore and never produce would not be subject to a social cost of greenhouse gas surcharge under this approach (as no royalty would ever be paid), the calculation of the royalty surcharge is based on aggregate 2017 emissions and thus producing leases would incur the social cost of emissions from the non-producing leases.

[8] BOEM's oil and gas price estimate was determined in 2021 using information available from the Energy Information Administration's Short Term Energy Outlook and Annual Energy Outlook.

IV. Conclusion

BOEM finds that, should a royalty rate surcharge be required for leasing, an adder of 2.25 percent is appropriate to meet the Administration's objectives described in E.O. 14008.[9]

[9] The Inflation Reduction Act sets the maximum royalty rate of 18.75% for the next 10 years. BOEM would be unable to add the surcharge for leases that would already be offered at that rate.