December 2024

Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2023: Updates Under Consideration to Use New Offshore Data

This memo discusses updates under consideration for the 2025 *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (GHGI) to incorporate new offshore emissions data. Year 2021 emissions data are available from the Bureau of Ocean Energy Management (BOEM) and EPA reviewed these data to consider updating the emission factors (EFs) that are used to calculate offshore emissions in the Gulf of Mexico (GOM).

EPA is incorporating the updates under consideration presented in this memo in the upcoming public review version of the 2025 GHGI. EPA will consider stakeholder feedback on the updates under consideration for inclusion in the final version of the 2025 GHGI.

1 Current GHGI Methodology

The current GHGI (i.e., 2024 GHGI) calculates emissions in the GOM for two areas: federal waters and state waters. For GOM federal waters, also referred to as the Outer Continental Shelf (OCS), data are available from the Bureau of Ocean Energy Management (BOEM). The emissions from GOM federal waters are then used to estimate emissions for GOM state waters, as discussed below. The current GHGI methodology for offshore production in the GOM is documented in the memo *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2018: Updates for Offshore Production Emissions* (referred to as the 2020 Offshore Production memo).[1]

For GOM federal waters production, EPA calculates emissions for four categories of complexes, based on unique combinations of subcategories. Each complex is classified as either an oil or gas complex and either a major or minor complex. Section 3 provides additional background on the subcategories. The four resulting complex categories are:

- oil, major complexes;
- gas, major complexes;
- oil, minor complexes; and
- gas, minor complexes.

For major complexes in GOM federal waters, EPA applies year-specific and source-specific EFs at the complex level (i.e., emissions per complex) developed from the BOEM Gulfwide Emissions Inventory (GEI) dataset to estimate vent and leak emissions over the GHGI time-series for major complexes. EPA specifically developed an approach for major complexes where the BOEM GEI-based EFs for a particular year are generally used for the Inventory years on either side of the BOEM GEI year that provides the EF, as follows:

- EFs calculated from the 2005 BOEM GEI are applied to year 2005 only (due to the abnormal hurricane season impact);
- EFs calculated from the 2008 BOEM GEI are applied to 1990 through 2004 and 2006 through 2009;
- EFs calculated from the 2011 BOEM GEI are applied to 2010 through 2012;
- EFs calculated from the 2014 BOEM GEI are applied to 2013 through 2015; and
- EFs calculated from the 2017 BOEM GEI are applied to 2016 through 2022.

For minor complexes in GOM federal waters, EPA applies the 2014 and 2017 BOEM GEI minor complex source-specific EFs to estimate vent and leak emissions. EPA applies minor complex EFs calculated from the 2014 BOEM GEI to 1990 through 2015 and minor complex EFs calculated from the 2017 BOEM GEI to 2016 through 2022.

[1] The 2020 Offshore Production memo is available here: https://www.epa.gov/sites/default/files/2020-04/documents/2020_ghgi_update_-_offshore_production_final.pdf

EPA uses the BOEM Platform Database to count total active complexes, subcategorized by major versus minor complexes, over the time series. EPA then uses the BOEM Oil and Gas Operations Reports – Part A (OGOR-A) Production Dataset to further subcategorize complexes as gas versus oil production.

EPA estimates flaring emissions in GOM federal waters using EFs on the basis of kg/MMBtu (along with year-specific heat content) coupled with flared gas volumes. Flared gas volumes over the time series are available from historical activity data and BOEM Oil and Gas Operations Reports – Part B (OGOR-B) data.

EPA calculates GOM state waters production emissions by developing year-specific production-based EFs from the GOM federal waters data. EPA calculates EFs by dividing the GOM federal waters emissions for an emission source by the GOM federal waters production in each year. The production basis is also unique for oil complexes and gas complexes; oil production is used for oil complexes and gas production is used for gas complexes. EPA then uses annual state-specific offshore production paired with the production-based EFs to calculate emissions.

2 Available Data

The BOEM GEI is a periodic emissions inventory that estimates criteria pollutant and GHG emissions from offshore oil and gas production sources in GOM federal waters, and a new inventory is now available for the year 2021.[2] With the publication of the 2021 inventory there was a name change for the study. The newest study is titled *Outer Continental Shelf Air Quality System (OCS AQS): Year 2021 Emissions Inventory Quality Assurance/Quality Control (QA/QC) Study*. We refer to this as the BOEM 2021 OCS Emissions Inventory. The BOEM 2021 OCS Emissions Inventory provides similar information as the prior BOEM GEI studies, including emissions by source for each complex.

3 Analysis of Available Data

EPA reviewed and analyzed the BOEM 2021 OCS Emissions Inventory data to consider its use for updating the offshore production GOM calculation methodology in recent years of the GHGI time series. To calculate EFs from the BOEM 2021 OCS Emissions Inventory data, we applied the same approach that was previously used when calculating EFs from the BOEM GEI datasets. These details are available in the 2020 Offshore Production memo and key steps are summarized here. We split the BOEM 2021 OCS Emissions Inventory dataset into the following subcategories using separate datasets:

- Oil complex versus gas complex: The BOEM 2021 OCS Emissions Inventory does not explicitly define each complex as gas or oil, and we rely on BOEM OGOR-A production data to make these assignments. EPA applied the typical GHGI methodology to designate each lease, Area/Block, and Area as gas- or oil-production; entities with a gas-to-oil ratio (GOR) greater than 100 mcf/bbl are classified as gas-producing, and entities with a GOR less than 100 mcf/bbl as oil-producing. Complexes were then matched to leases, Blocks, and Areas (in order of decreasing granularity) and the match with the highest granularity was used to make the oil versus gas assignment (e.g., if a complex could be matched to a lease, then the lease GOR was used to make the oil versus gas assignment, but if a complex was not matched to a lease then the Area/Block-level GOR was used to make the oil versus gas assignment).
- Major versus minor complex: The BOEM 2021 OCS Emissions Inventory does not explicitly define each complex as major or minor but the BOEM Platform Database includes details for each complex, including whether each structure at a complex is "major" or "minor". A major structure is defined as containing at least six well completions or containing more than two pieces of production equipment; otherwise the structure is defined as minor. If a complex contained at least one major structure, then the complex was classified as major.

[2] Each emissions inventory study is available here: https://www.boem.gov/environment/environmental-studies/ocs-emissions-inventories

Once each complex in the BOEM 2021 OCS Emissions Inventory was assigned to gas versus oil complex and major versus minor complex, EPA calculated emission source-level EFs for each category. The EFs equal the sum of source-level emissions divided by the applicable complex count for each category. Table 3-1 presents the EFs calculated for major complexes from the BOEM 2021 OCS Emissions Inventory data and from the most recent BOEM 2017 GEI data, for comparison. Table 3-2 presents the same information for minor complexes in the BOEM 2021 OCS Emissions Inventory data and the BOEM 2017 GEI data.

Table 3-1. Summary of Emissions and Calculated EFs for Major Complexes in BOEM 2017 GEI Data and BOEM 2021 OCS Emissions Inventory Data

Emission Source	2017 GEI Data			2021 OCS Emissions Inventory Data		
	Complex Count	CH_4 Emissions (mt)	Complex CH_4 EF (mt/yr)	Complex Count	CH_4 Emissions (mt)	Complex CH_4 EF (mt/yr)
Oil, Major Complexes						
Cold Vent	550	55,997	**101.8**	559	32,055	**57.3**
Fugitives		39,340	**71.5**		21,185	**37.9**
Pneumatic Pump		18,027	**32.8**		8,446	**15.1**
Losses from Flashing		3,516	**6.4**		1,107	**2.0**
Pneumatic Controller		11,035	**20.1**		5,081	**9.1**
Combustion		8,532	**15.5**		3,411	**6.1**
Glycol Dehydrator Unit		431	**0.8**		292	**0.5**
Storage Tank		479	**0.9**		222	**0.4**
Mud Degassing		78	**0.1**		69	**0.1**
Minor Surrogate		0	**0.0**		0	**0.0**
Amine Gas Sweetening Unit		0	**0.0**		0	**0.0**
Gas, Major Complexes						
Cold Vent	92	6,023	**65.5**	93	604	**6.5**
Fugitives		4,830	**52.5**		1,018	**10.9**
Pneumatic Pump		3,995	**43.4**		96	**1.0**
Losses from Flashing		43	**0.5**		6	**0.1**
Pneumatic Controller		2,076	**22.6**		307	**3.3**
Combustion		648	**7.0**		193	**2.1**
Glycol Dehydrator Unit		9	**0.1**		0	**0.0**
Storage Tank		16	**0.2**		5	**0.0**
Mud Degassing		0	**0.0**		0	**0.0**
Minor Surrogate		0	**0.0**		0	**0.0**
Amine Gas Sweetening Unit		3	**0.0**		0	**0.0**

Table 3-2. Summary of Emissions and Calculated EFs for Minor Complexes in BOEM 2017 GEI Data and BOEM 2021 OCS Emissions Inventory Data

Emission Source	2017 GEI Data			2021 OCS Emissions Inventory Data		
	Complex Count	CH_4 Emissions (mt)	Complex CH_4 EF (mt/yr)	Complex Count	CH_4 Emissions (mt)	Complex CH_4 EF (mt/yr)
Oil, Minor Complexes						
Cold Vent	290	1,587	**5.5**	355	3,635	**10.2**
Fugitives		4,282	**14.8**		3,219	**9.1**
Pneumatic Pump		3,609	**12.4**		2,273	**6.4**
Losses from Flashing		100	**0.3**		4	**0.0**
Pneumatic Controller		848	**2.9**		338	**1.0**
Combustion		462	**1.6**		632	**1.8**
Glycol Dehydrator Unit		64	**0.2**		3	**0.0**
Storage Tank		5	**0.0**		0	**0.0**
Mud Degassing		0	**0.0**		50	**0.1**
Minor Surrogate		0	**0.0**		0	**0.0**
Amine Gas Sweetening Unit		0	**0.0**		0	**0.0**
Gas, Minor Complexes						
Cold Vent	61	339	**5.6**	70	63	**0.9**
Fugitives		752	**12.3**		213	**3.0**
Pneumatic Pump		278	**4.6**		196	**2.8**
Losses from Flashing		0	**0.0**		0	**0.0**
Pneumatic Controller		76	**1.2**		32	**0.5**
Combustion		87	**1.4**		6	**0.1**
Glycol Dehydrator Unit		1	**0.0**		0	**0.0**
Storage Tank		0	**0.0**		0	**0.0**
Mud Degassing		0	**0.0**		0	**0.0**
Minor Surrogate		0	**0.0**		0	**0.0**
Amine Gas Sweetening Unit		0	**0.0**		0	**0.0**

To more easily compare the EFs calculated from the 2021 and 2017 emissions inventory datasets, EPA summed the emission source-level emissions and calculated an overall average EF for each category. Table 3-3 summarizes the resulting average EFs for each category and dataset and presents the percent change in the EFs between the 2017 and 2021 datasets. Figure 1 visually depicts the average EFs for each category for the 2017 and 2021 datasets. There is a noticeable decrease in EFs calculated from the BOEM 2021 OCS Emissions Inventory.

Table 3-3. Comparison of Average EFs by Category Calculated From the BOEM 2017 GEI and the BOEM 2021 OCS Emissions Inventory Data

Oil or Gas Complex	Major or Minor Complex	2017 GEI Data			2021 OCS Emissions Inventory Data			% Change in EF From 2017 to 2021
		Complex Count	CH_4 Emissions (mt)	Complex CH_4 EF (mt/yr)	Complex Count	CH_4 Emissions (mt)	Complex CH_4 EF (mt/yr)	
Oil	Major	550	137,435	**250**	559	71,867	**129**	-49%
Gas	Major	92	17,642	**192**	93	2,230	**24**	-87%
Oil	Minor	290	10,957	**38**	355	10,155	**29**	-24%
Gas	Minor	61	1,533	**25**	70	509	**7**	-71%

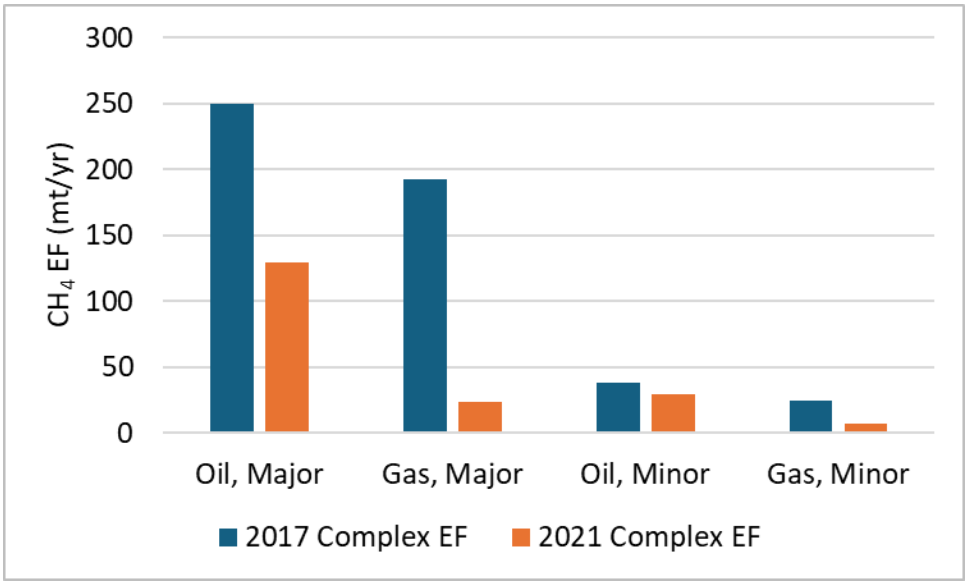

Figure 1. Comparison of Average EFs by Category Calculated From the BOEM 2017 GEI and the BOEM 2021 OCS Emissions Inventory Data

The BOEM studies represent emissions for offshore production in GOM federal waters. As discussed in Section 1, the GOM federal waters data are used to calculate GOM state waters emissions. This approach would not change for the update under consideration, and as a result, any decrease in GOM federal waters emissions would translate to a similar decrease for GOM state waters emissions.

4 Time Series Considerations

EPA currently applies the EFs calculated from the BOEM 2017 GEI for 2016 through 2022. For the update under consideration for the 2025 GHGI, EPA is considering applying the EFs calculated from the BOEM 2017 GEI for 2016 through 2018, EFs calculated from the BOEM 2021 OCS Emissions Inventory for 2020 through 2023, and calculating EFs that average both studies together for year 2019. The methodology for all other years of the time series would not be impacted by the update under consideration. EPA is also considering an alternative approach to incorporating the BOEM data across the time series; see Question 1 in Section 6 for further information.

5 National Emissions Estimates for Update Under Consideration for Offshore Production in the GOM

Table 5-1 presents the year 2022 CH_4 emission estimates for offshore GOM Federal and state waters for the 2024 GHGI and the updates under consideration for the 2025 GHGI. Oil complex CH_4 emissions are 45 percent lower, gas complex CH_4 emissions are 86 percent lower, and overall offshore GOM Federal and state waters CH_4 emissions are 50 percent lower in year 2022, for the update under consideration compared to the 2024 GHGI. Figure 2 compares CH4 emissions for the 2024 GHGI and the updates under consideration for the 2025 GHGI, for the years that would be impacted by the update (i.e., 2019 – 2022). Appendix A presents a more granular emissions comparison for the 2024 GHGI versus the updates under consideration for the 2025 GHGI over 2019 – 2022.

Table 5-1. Comparison of CH_4 Emissions (mt) for the 2025 GHGI Updates Under Consideration and the 2024 GHGI, for Year 2022

Complex Type	Current 2024 GHGI (Year 2022)	Update Under Consideration for 2025 GHGI (Year 2022)
Oil Complexes	**164,395**	**89,752**
Offshore GOM Federal Waters	164,320	89,280
Offshore GOM State Waters	75	472
Gas Complexes	**22,712**	**3,231**
Offshore GOM Federal Waters	12,757	1,815
Offshore GOM State Waters	9,955	1,416
Total	**187,107**	**92,983**

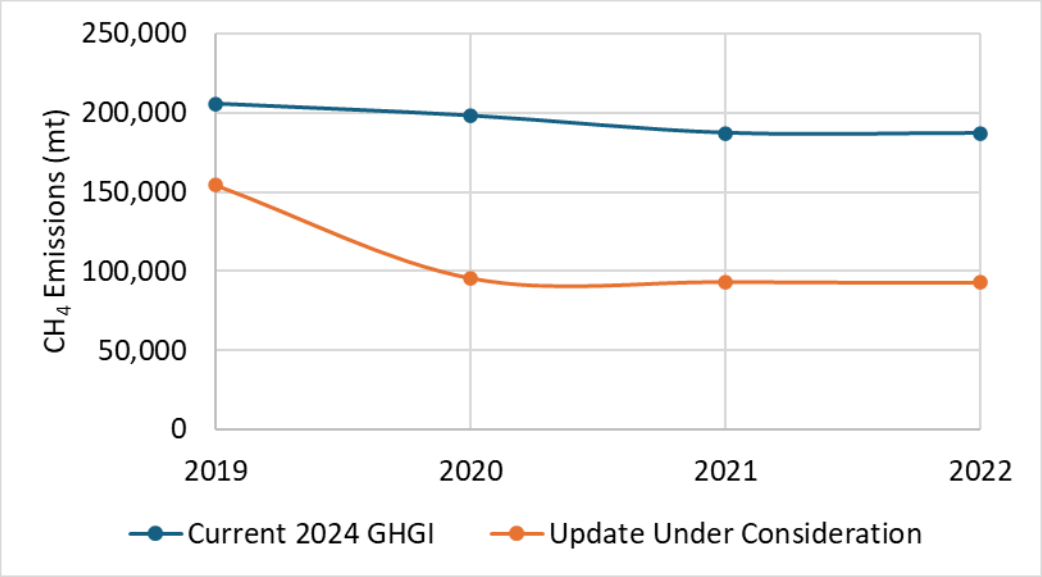

Figure 2. Comparison of CH_4 Emissions (mt) for the 2025 GHGI Updates Under Consideration and the 2024 GHGI, for Years 2019 - 2023

6 Requests for Stakeholder Feedback

EPA seeks stakeholder feedback on the updates under consideration discussed in this memo and the question below.

1. How should EPA incorporate the EFs calculated from the BOEM emissions inventory studies for the non-study years? EPA currently applies the BOEM-based EFs for the Inventory years on either side of the BOEM study (e.g., 2011 BOEM GEI is used for 2010-2012, 2014 BOEM GEI is used for 2013-2015). In the update under consideration, the approach discussed in Section 4 follows this basic approach. As an alternative, EPA is also considering the time series approach summarized below, in order to smooth trends over time which may be more reflective of the gradual change in emissions between years:
    a. EFs calculated from the 2005 BOEM GEI would be applied to year 2005 only (due to the abnormal hurricane season impact);
    b. EFs calculated from the 2008 BOEM GEI would be applied to 1990 through 2004 and 2006 through 2008;
    c. Linear interpolation would be applied between the EFs calculated from 2008 BOEM GEI and the 2011 BOEM GEI for 2009 and 2010;
    d. EFs calculated from the 2011 BOEM GEI would be applied to 2011;
    e. Linear interpolation would be applied between the EFs calculated from 2011 BOEM GEI and the 2014 BOEM GEI for 2012 and 2013;
    f. EFs calculated from the 2014 BOEM GEI would be applied to 2014;
    g. Linear interpolation would be applied between the EFs calculated from 2014 BOEM GEI and the 2017 BOEM GEI for 2015 and 2016;
    h. EFs calculated from the 2017 BOEM GEI would be applied to 2017;
    i. Linear interpolation would be applied between the EFs calculated from 2017 BOEM GEI and the BOEM 2021 OCS Emissions Inventory for 2018-2020; and
    j. EFs calculated from the BOEM 2021 OCS Emissions Inventory would be applied for 2021 forward.

Appendix A – Time Series CH_4 Emissions for Offshore Production in the GOM for the Current 2024 GHGI Compared to the Updates Under Consideration for the 2025 GHGI

Table A-1. Offshore GOM CH_4 Emissions (mt) for 2019 - 2022 for the 2024 GHGI and the 2025 GHGI Updates Under Consideration

Complex Type	2019	2020	2021	2022
Current 2024 GHGI				
Oil Complexes	**178,558**	**167,001**	**165,720**	**164,395**
Offshore GOM Federal Waters	178,488	166,931	165,651	164,320
Oil, Major Complexes	156,711	146,448	145,910	144,791
Oil, Minor Complexes	21,776	20,483	19,741	19,529
Offshore GOM State Waters	71	69	68	75
Gas Complexes	**27,136**	**31,148**	**21,533**	**22,712**
Offshore GOM Federal Waters	16,514	17,401	11,373	12,757
Gas, Major Complexes	14,739	15,519	10,179	11,421
Gas, Minor Complexes	1,775	1,881	1,194	1,335
Offshore GOM State Waters	10,622	13,748	10,160	9,955
Total	**205,694**	**198,149**	**187,253**	**187,107**
Update Under Consideration for 2025 GHGI				
Oil Complexes	**138,636**	**91,335**	**90,412**	**89,752**
Offshore GOM Federal Waters	137,801	90,856	90,017	89,280
Oil, Major Complexes	118,669	75,347	75,070	74,495
Oil, Minor Complexes	19,132	15,509	14,947	14,786
Offshore GOM State Waters	834	480	394	472
Gas Complexes	**15,521**	**4,449**	**3,064**	**3,231**
Offshore GOM Federal Waters	9,435	2,485	1,618	1,815
Gas, Major Complexes	8,291	1,940	1,273	1,428
Gas, Minor Complexes	1,145	545	346	387
Offshore GOM State Waters	6,086	1,963	1,446	1,416
Total	**154,157**	**95,784**	**93,476**	**92,983**