April 2020

Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2018: Updates for Offshore Production Emissions

1 Background

This memorandum documents the updates implemented in EPA's 2020 *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (GHGI) for offshore production facilities in natural gas and petroleum systems. Additional considerations for offshore production were previously discussed in memoranda released in September 2019 (*Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2018: Updates Under Consideration for Offshore Production Emissions*) and April 2018 (*Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2016: Additional Revisions Considered for 2018 and Future GHGIs*).[1] All figures within this memo (i.e., Figure 1 through Figure 19) are shown in Appendix A.

1.1 Industry Overview

Offshore oil and gas production facilities can include production structures and supporting structures. A production structure can contain emission sources such as gas-oil separation, well unloading, equipment leaks, gas dehydration, acid gas removal, liquid hydrocarbon storage, and gas compression. A portion of these production structures have associated support structures such as caissons, wellhead protectors, and living quarters. The production structure and any associated support structures form what is referred to as a *complex* for the purposes of this memo. Certain data sources use the term "platform"—typically interchangeably with "structure." For clarity, this memo uses a terminology convention of "structure" and "complex" when discussing offshore production facilities.

Offshore production complexes operate in waters that are under federal government jurisdiction (federal waters) or state government jurisdiction (state waters). Federal waters are referred to as the Outer Continental Shelf (OCS), and include producing regions in the Gulf of Mexico (GOM), the Pacific Ocean (off the continental U.S. western coast), and surrounding Alaska (including the Beaufort and Chukchi Seas, the Bering Sea, Cook Inlet and the Gulf of Alaska)[2]. To this point, there has not been production in the OCS surrounding Alaska.[3] State waters consist of the 3 nautical mile area that extends off state coasts, but some areas (including Texas, Puerto Rico, and the west coast of Florida) control the waters for as much as 9 or 12 nautical miles off their coasts. Offshore facilities in state waters are located in the same three geographic areas as federal waters facilities; in the GOM and off the coasts of California and Alaska.

An overview of offshore oil and gas production in federal and state waters is provided in Figure 1 for year 2017 (the most recent year with detailed emissions data available from data sources reviewed). The data sources for Figure 1 include the Department of Interior (DOI)/Bureau of Ocean Energy Management (BOEM)[4] for federal waters production, and state agencies for state waters production (see Section 3.6 for the data source specific to each state waters region). Offshore facilities in GOM federal waters produce the vast majority of both offshore oil and gas.

[1] Stakeholder materials including draft and final memoranda for the current 1990-2018 Inventory and previous Inventories are available at https://www.epa.gov/ghgemissions/natural-gas-and-petroleum-systems.
[2] https://www.boem.gov/Alaska-Region/
[3] https://www.doi.gov/pressreleases/interior-approves-long-awaited-first-oil-production-facility-federal-waters-offshore
[4] https://www.data.boem.gov/Production/OCSProduction/Default.aspx

2 Overview of Previous (2019) GHGI Methodology

The previous GHGI used emission factors (EFs) developed from year 2011 BOEM data across the entire time series. The following sections summarize the data sources and methodology for the previous GHGI approach to estimating vented and leak emissions (Section 2.1) and flaring emissions (Section 2.2).

2.1 Vented and Leak Emissions

To calculate vented and leak emissions from offshore production facilities in the previous GHGI, EPA used EFs developed from BOEM's 2011 Gulfwide Emission Inventory (GEI), which relied on activity data from the 2011 Gulfwide Offshore Activity Data System (GOADS). Refer to Section 3.1 for more information on this data source. EPA developed EFs for four offshore production facility categories: deepwater gas, deepwater oil, shallow water gas, and shallow water oil. EPA calculated EFs on both a complex basis and a structure basis to compare and consider the appropriateness of each. The methodology to calculate the EFs is documented in the memo *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2013: Revision to Offshore Platform Emissions Estimate (2015 Offshore Updates memo).*[5]

Because the existing activity data in the previous GHGI were based on a count of structures, the previous GHGI used structure-based EFs. Table 1 presents the previously used EFs in metric tons per year (mt/yr) for methane (CH_4) and carbon dioxide (CO_2) developed from the 2011 BOEM GEI. The complex-based EFs (considered but not used) are presented in the second column, and the structure-based EFs (used in the previous GHGI) are presented in the third column.

As seen in Table 1, when gas facilities are defined as producing more than 100 thousand cubic feet of gas per barrel of hydrocarbon liquid (mcf/bbl), there are no deepwater gas facilities in the 2011 BOEM GEI dataset, resulting in no EF for this facility group. EPA assigned the deepwater oil facility EF to deepwater gas facilities as a surrogate. Note, the calculated CO_2 EFs exclude flaring emissions (which are calculated as explained in Section 2.2), but the CH_4 EFs include CH_4 emissions from flaring as well as combustion engine exhaust.

Table 1. Methodology for Previous GHGI—EFs Based on 2011 BOEM GEI

Pollutant/Facility Category	Complex EF[a] (mt/yr)	Structure EF (mt/yr)
CH_4		
Deep Gas	– [b]	– [b]
Deep Oil	656	656
Shallow Gas	71	62
Shallow Oil	137	116
CO_2 [c]		
Deep Gas	– [b]	– [b]
Deep Oil	7.7	7.7
Shallow Gas	1.3	1.2
Shallow Oil	2.3	1.9

a – EFs considered for updates to the 2015 GHGI, but not ultimately used.
b – No available data to calculate. EPA assigned the deepwater oil facility EF to deepwater gas facilities as a surrogate.
c – CO_2 EFs exclude flaring emissions.

The activity data paired with the structure-based EFs was the number of offshore structures in federal waters of the GOM that are existing in each year of the time series, in each category (deepwater gas, deepwater oil, shallow

[5] https://www.epa.gov/sites/production/files/2015-12/documents/revision-offshoreplatforms-emissions-estimate-4-10-2015.pdf

water gas, and shallow water oil), based on a nationwide Department of Interior (DOI)/Mineral Management Service (MMS) facility census. The MMS facility census had not been updated since 2010 (when the agency was reorganized), so the previous GHGI used year 2010 activity as surrogate for all later time series years. Additionally, the MMS data source did not differentiate between active and inactive structures, so all structures in the dataset were considered active. The previous GHGI methodology also did not account for emissions from offshore structures that are located in state waters or in federal Pacific waters.

2.2 Flaring Emissions

In the previous GHGI, EPA calculated CO_2 emissions from all offshore flaring activities as a single line item appearing within the natural gas systems segment. As stated in Section 2.1, the minimal CH_4 emissions from flaring were included in the CH_4 EFs calculated from the 2011 BOEM GEI data, shown in Table 1. The basis for the CO_2 estimate was the total volume of gas vented and flared at offshore facilities in federal waters of the GOM and the estimated percentage of this gas that was flared. These data were provided by DOI/MMS staff, based on annual data collected in their Oil and Gas Operations Reports (OGOR) covering 1990 through 2008. Since 2009, this data had not been available, so the previous GHGI used year 2008 values for all later time series years. Information that would allow separation of these data into flaring from oil versus gas facilities was not available from MMS, leading to the previous GHGI approach of reporting all offshore CO_2 flaring emissions under natural gas systems. Similar to the vented and leak emissions methodology, the previous GHGI flaring emissions methodology did not account for flaring at offshore facilities that are located in state waters or in federal Pacific waters. Note, while flaring emissions are calculated for the BOEM GEI, the previous GHGI approach relied on the volume of flared gas because it is more readily available across the time series, compared to BOEM GEI data which are only available for certain years.

The previous GHGI offshore flaring CO_2 EF, applied to the quantity of gas flared, is from the Energy Information Administration (EIA), and relies on the carbon content of natural gas. EIA provides a value of 54.7 kilograms of CO_2 per million BTU (kg/mmBTU) of flared natural gas.[6] The previous GHGI methodology used this EF for all time series years, with year-specific natural gas heat content (Btu/scf) from EIA's *Monthly Energy Review* publication.[7] Note, the flaring CO_2 EF from EIA (54.7 kg/mmBTU, equivalent to 120.6 lb/mmBTU) is similar to the EF of 114.285 lb/mmBTU that BOEM uses to calculate flaring CO_2 emissions for the GEI.

3 Available Data

EPA evaluated several data sources that provide emissions and/or activity data for offshore production sources. The data sources included the BOEM GEI, BOEM OGOR data, the BOEM Platform Database, and the Greenhouse Gas Reporting Program (GHGRP). Table 2 provides a general review of the information available from each source, and Sections 3.1 through 3.5 discuss each source in detail. Section 3.6 discusses other data sources that were evaluated, which are available from: the Oil and Gas Board of Alabama, the Louisiana Department of Wildlife and Fisheries, the Louisiana Department of Natural Resources, the Texas General Lands Office, the Texas Railroad Commission, the California State Lands Commission, the California Department of Conservation, and the Alaska Oil and Gas Conservation Commission.

[6] https://www.eia.gov/environment/emissions/co2_vol_mass.php

[7] See Table A4, Approximate Heat Content of Natural gas (Btu per cubic foot), available at https://www.eia.gov/totalenergy/data/monthly/pdf/sec13_5.pdf

Table 2. Data Sources with Emissions and/or Activity Data for Offshore Production

Parameter	Data Source				
	BOEM GEI	**BOEM OGOR-A**	**BOEM OGOR-B**	**BOEM Platform Database**	**EPA GHGRP**
Summary	Triennial Gulfwide emissions inventory	Offshore oil and gas production data	Offshore vented and flared gas volumes	Offshore structures, dates, depths, etc.	Annual emissions data from facilities required to report
Geographic coverage	Gulf only	Gulf and Pacific	Gulf only	Gulf and Pacific	All that meet or exceed threshold
Federal vs. state waters	Federal only	Federal only	Federal only	Federal only	All that meet or exceed threshold
Estimation frequency	Triennial (2000, 2005, 2008, 2011, 2014, 2017)	Monthly	Monthly	Monthly	Annual (2011 – 2018)
Pollutants	Criteria, criteria precursors, GHG	n/a – activity (not emissions)	n/a – flared volumes data (not emissions)	n/a – activity (not emissions)	GHG
Emission sources	All	n/a – activity (not emissions)	Flares and vents	n/a – activity (not emissions)	Subpart W: Vented, leak, flares Subpart C: Combustion
Facility definition	Structures and complexes	Lease, Area/Block	Lease	Structures and complexes	Complexes
Reporting requirement	All active and inactive facilities, but some facilities fail to report for various reasons	All facilities	All facilities	All facilities	Only facilities with ≥ 25,000 mt CO2e emissions

3.1 BOEM Gulfwide Emissions Inventory (GEI)

This section summarizes the scope and available data from the BOEM GEI publications and explains how EPA used the data in the updated methodology for the 2020 GHGI.

3.1.1 Scope and Available Data

The BOEM GEI estimates criteria pollutant and GHG emissions from offshore oil and gas production sources in GOM federal waters. The BOEM GEI does not account for emissions from sources in GOM state waters or off the coasts of California and Alaska. All offshore facilities in GOM federal waters that are west of 87.5 degrees longitude are required to report data to BOEM[8], in order to comply with 30 CFR 550.304, and BOEM issues a Notice to Lessees and Operators (NTL) which provides instructions for each GEI.[9] BOEM collects monthly activity data from OCS operators in the GOM via the Gulfwide Offshore Activities Data System (GOADS), then BOEM calculates emission source-specific emissions. GEI studies are available for years 2000, 2005, 2008, 2011, 2014, and 2017.[10] Each GEI provides emissions and activity data for active offshore structures, and counts of inactive structures. GHG emissions are estimated for the following emission sources on an active offshore structure: amine units; boilers, heaters, and burners; combustion flares; drilling equipment (for drilling rigs attached to an offshore structure); engines; equipment leaks (valves, flanges, connectors); glycol dehydrators; losses from flashing; mud degassing; turbines; pneumatic pumps; pressure and level controllers; storage tanks; and cold vents. Each emission source uses a documented methodology to calculate emissions, and most rely on equations or EFs that

[8] All existing offshore production facilities in the GOM are located west of 87.5 degrees longitude.
[9] The 2017 GEI NTL is available at https://www.boem.gov/BOEM-NTL-2016-N03/.
[10] Each GEI study is available online: https://www.boem.gov/Gulfwide-Offshore-Activity-Data-System-GOADS/

relate throughput (or other activity data) to emissions. Sources for methods and EFs include, among others, API 1996 for fugitive EFs, EIIP 1999 for equations for pneumatic pumps and controllers, and AP-42 for EFs for engines.[11] BOEM also recognizes a non-reporter population (i.e., active structures that are expected to report but do not), and these non-reporters were evaluated in the 2014 and 2017 GEI studies. Table 3 provides a summary of the BOEM GEI activity and emissions data. EPA grouped the BOEM GEI emissions into categories of vent and leak (including engine exhaust CH_4) emissions and flaring emissions.

Table 3. BOEM GEI Reporting Overview

Data	2000	2005	2008	2011	2014	2017
# Active & Inactive Structures	3,154	1,619	3,304	3,051	1,856	1,842
# Active Structures	2,873	1,585	3,026	2,544	1,651	1,194
# Non-Reporting Structures (estimate[a])	NE	NE	583	538	250	250
# Active Complexes	2,529	1,407	2,614	2,205	1,397	995
Flared Volume (MMcf)	2,498	5,104	6,985	10,074	5,123	6,265
Vent and Leak Emissions						
CH_4 (mt)	510,014	194,294	383,073	245,838	204,420	167,567
CO_2 (mt)	8,511	2,160	4,282	4,009	3,394	2,687
Flare Emissions						
CH_4 (mt)	144	296	401	332	301	2,888
CO_2 (mt)	263[b]	9,785[b]	380,186	547,942	278,861	459,274
N_2O (mt)	<1	0.2	7	10	5	8

NE – Not estimated.
a – The GEI estimated 85%-90% of all active offshore structures reported in the 2008, 2011, and 2014 GEIs.
b – The 2000 and 2005 BOEM GEIs calculated flaring CO_2 emissions based on the calculation requirements applicable to the GEI in those years (i.e., only flare pilot CO_2 emissions were calculated). See the following paragraph for information regarding flare emissions in early years.

The BOEM reporting requirements have changed across the GEIs, and certain years had unique circumstances that affected reporting which EPA took into account when assessing data for incorporation into GHGI updates. Important changes and circumstances include:

- Flare CO_2 emissions in early years
    - Flare CO_2 emissions were not fully accounted for in the 2000 and 2005 GEIs, and only flare pilot CO_2 emissions are included—i.e., flare CO_2 emissions in these years are inconsistent with reported flared gas volumes (which are reported via GOADS for these years), so EPA would need to apply additional calculations to use such data for GHGI EFs.
- Minor source structure emissions in early years
    - Minor source structures include caissons, wellhead protectors, living quarters, and "other" unclassified structures.
    - In years 2000 and 2005, offshore operators were not required to report any data for minor source structures to GOADS.
    - In years 2008 and 2011, offshore operators were required to identify minor source structures in GOADS, but were not required to provide detailed activity data for the emission sources on the structures. BOEM calculated emissions from minor source structures for the 2008 and 2011 GEIs by applying default EFs to each type of minor source structure.
    - Beginning in the 2014 GEI, minor source structures are treated the same as all other structures. As such, operators reported all activity data for emission sources on minor source structures through GOADS and the emissions were fully accounted for in the 2014 and 2017 GEIs.

[11] Each GEI study documents the methodologies applied to each emission source. For example, see Section 4.2 in the 2014 GEI study for the complete emission estimation procedures.

- 2005 GEI hurricane season impact
    - There was a significant impact on offshore production operations in year 2005 due to a particularly severe hurricane season.
    - As a result, the number of structures and complexes reported was very low, and those that did report showed particularly low levels of activity (and corresponding low calculated emissions).
    - Therefore, as discussed in Section 4.1.1, EPA limited the application of year 2005 GEI data in the GHGI (i.e., did not use year 2005 data as surrogate for surrounding years).
- Year 2000, first year of reporting
    - There have been updates in GEI inventory calculation methods and operator understanding and delivery of data since the first year of reporting underlying the year 2000 GEI (refer to the 2014 GEI report, Appendix B trends analysis discussion).
    - Therefore, as discussed in Section 3.1.2, EPA excluded year 2000 GEI data from the GHGI updates.

3.1.2 Considerations for Use in 2020 GHGI Updates

The 2011 BOEM GEI is the basis of the previous GHGI EFs, but GEIs are available for years 2000, 2005, 2008, 2011, 2014, and 2017. In updating the 2020 GHGI, EPA calculated EFs using each year of the BOEM GEI data such that trends are reflected over the time series. EPA updated the EF basis in two ways: (1) switched from a structure-basis to a complex-basis; and (2) established EF subcategories for "major" versus "minor" complexes, instead of the previous water depth subcategories. This section details these and other considerations for updating the 2020 GHGI.

3.1.2.1 Complex-Level EFs

EPA calculated EFs at the complex level from GEI data to emphasize the activity data unit most related to the presence of production operations and likely correlated to emissions levels (i.e., a complex produces oil and gas with possibly significant emissions, or is alternatively a collection of likely low-emitting supporting structures). Multi-structure complexes that have a production structure and other supporting structures were considered as a single unit. Complexes with one or more non-production structures were also considered a single unit, likely with low emissions. This level of categorization then leads to consideration of "major" versus "minor" complexes as discussed in Section 3.1.2.2.

3.1.2.2 Major versus Minor Complexes

EPA introduced new EF subcategories to differentiate major and minor complexes in order to represent differences in complexity and processing capabilities (i.e., equipment types present) which are expected to correlate with emissions. This approach replaced the previous subcategorization scheme based on water depth, which more indirectly correlated with emissions (i.e., while deep water facilities tend to have higher per-facility emissions than shallow water facilities, emissions are not a direct function of water depth).

To categorize GEI complexes as major versus minor, EPA crosswalked individual complexes between the GEI and another BOEM data source, the BOEM Platform Database (discussed in Section 3.2). The BOEM Platform Database designates all structures as "major" or "minor" structures.[12] 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. Using this designation, EPA classified each existing complex in the BOEM Platform Database that has at least one major structure as a major complex. EPA then matched the complex IDs in the BOEM GEI with the complex IDs and their major or minor complex classifications from the BOEM Platform Database.

[12] This is not to be confused with minor source structures in the GEI, as discussed in Section 3.1.1. It is likely that GEI minor source structures are minor structures in BOEM's platform database (defined based on structure type), but not all minor structures in the BOEM Platform Database are minor source structures in the GEI.

3.1.2.3 Facility Production Type Assignment

In reviewing the previous GHGI methodology for developing EFs from GEI data, EPA identified an opportunity to improve estimates by utilizing more of the available GEI data. The previous GHGI methodology, as discussed in Section 2, relied on matching lease IDs between BOEM GEI and year 2011 OGOR-A production data (see Section 3.3 for a detailed discussion of OGOR-A data) in order to assign a production type (oil or gas) for each complex. However, not all BOEM GEI lease IDs could be matched to an OGOR lease ID, and thus certain complexes were unmatched and could not be used in the EF calculations. This population was relatively small, but a methodology that would allow EPA to use all BOEM GEI data is preferred.

In addition to lease IDs, BOEM GEI and OGOR-A also provide Area and Block IDs for each record. A Block is 3 miles by 3 miles and an Area is comprised of multiple Blocks. The relationship between leases and Area/Blocks can vary – leases can be part of a Block or can be in multiple Blocks. EPA calculated the gas-to-oil ratio (GOR) at the Area and Area/Block-level and assigned each as oil or gas to gap-fill those complexes which could not be assigned at the lease-level.

The previous GHGI oil versus gas assignments for each complex relied on year 2011 data, because the 2011 GEI is the basis of the EFs. However, for the 2020 GHGI updates, EPA evaluated data from additional GEI years and assigned production type for each complex based on data specific to that year, when possible. EPA used the existing GHGI convention that defines entities with a GOR greater than 100 thousand cubic feet (mcf) of gas per barrel (bbl) of hydrocarbon liquid as gas-producing, and defines entities with a GOR less than 100 mcf/bbl as oil-producing. Certain leases did not have production in a given GEI year, but did have production in surrounding years, and this information was used in the assignments.

EPA implemented a four-step process to assign production type for each complex in the GEI:

Step 1: Assign production type as oil versus gas based on year-specific lease-level production in OGOR-A (similar to previous GHGI approach).

Step 2: For those complexes not assigned in Step 1 because the lease did not have production in the specific GEI year, assign production type based on a nearest-year approach. The nearest-year approach looks to Step 1 production type assignments for a given complex in the years surrounding a particular GEI. For example, a complex in the 2008 GEI dataset that was not assigned a production type based on year 2008 data would look to assignments for that complex in the following preferential order: year 2007, 2009, 2006, 2010, etc.

Step 3: For those complexes not assigned in Step 1 or 2, assign complex to oil versus gas based on year-specific Area/Block-level production in OGOR-A.

Step 4: For those complexes not assigned in Steps 1 - 3, assign complex to oil versus gas based on year-specific Area-level production in OGOR-A.

Table 4 summarizes the number of complexes that were assigned as oil or gas in each step for each GEI.

Table 4. Number of GEI Complexes Assigned to Oil versus Gas, by Data Processing Step

Data Processing Step	2005		2008		2011		2014		2017	
	# Assigned To		# Assigned To		# Assigned To		# Assigned To		# Assigned To	
	Oil	Gas	Oil	Gas	Oil	Gas	Oil	Gas	Oil	Gas
Step 1: Year-Specific Lease-Level Production	845	449	1,550	719	1,358	539	1,007	214	754	116
Step 2: Nearest-Year Lease-Level Production	31	29	76	135	79	109	51	56	37	33

Data Processing Step	2005		2008		2011		2014		2017	
	# Assigned To		# Assigned To		# Assigned To		# Assigned To		# Assigned To	
	Oil	Gas	Oil	Gas	Oil	Gas	Oil	Gas	Oil	Gas
Step 3: Area/Block-Level Production	12	8	26	15	18	9	5	2	5	2
Step 4: Area-level Production	23	10	73	20	84	9	57	5	44	2
Total Complexes Assigned to Oil and Gas	**911**	**496**	**1,725**	**889**	**1,539**	**666**	**1,120**	**277**	**840**	**153**

3.1.2.4 Emission Factors

With the BOEM GEI complexes assigned to gas versus oil and major versus minor, according to the considerations in the preceding subsections, EPA calculated EFs for each subcategory. A summary of the number of complexes reporting to BOEM GEI under each subcategory is shown in Table 5. EPA calculated vent and leak EFs for the 2005, 2008, 2011, 2014, and 2017 GEIs on a complex basis for each subcategory, see Table 6. Vent and leak CH_4 and CO_2 EFs are depicted in Figure 2 and Figure 3. Stakeholders were also interested in calculating EFs for each emission source (see Section 5), and EFs for each vent and leak emission source are presented in Table 7 through Table 10, for reference. Vent and leak emissions account for all emission sources reported to the GEI, except for flares. EPA did not use flaring emissions from the GEI in the 2020 GHGI update, instead OGOR-B flaring volumes were applied over the time series (see Section 3.4). Offshore operators were not required to report data for minor source structures in the 2005 GEI (as discussed in Section 3.1.1) and there were fewer minor complexes that reported to the 2005 GEI as a result (see Table 5). In addition, the 2005 minor complex EFs are higher than minor complex EFs for other GEI years, because the 2005 GEI only includes the higher emitting minor complexes (compared to the lower emitting minor source structures, which are included in other GEI years). Note, the 2000 BOEM GEI (i.e., the first year of the GEI) was not considered for this analysis; see discussion in Section 3.1.1.

Table 5. Summary of BOEM GEI Complex Counts, by Subcategory

Oil/Gas Complex	Major/ Minor Complex	# Complexes				
		2005	2008	2011	2014	2017
Gas	Major	431	474	310	174	92
Oil	Major	798	858	737	667	550
Total	**Major**	**1,229**	**1,332**	**1,047**	**841**	**642**
Gas	Minor	65	409	349	103	61
Oil	Minor	111	853	791	451	290
Total	**Minor**	**176**	**1,262**	**1,140**	**554**	**351**
Total Used in EF Calcs		**1,405**	**2,594**	**2,187**	**1,395**	**993**
Total Reported to GEI[a]		**1,407**	**2,614**	**2,205**	**1,397**	**995**

a – Sum of major and minor complexes does not equal total number of complexes reported to the GEI because certain complexes could not be categorized. Section 3.1.2.2 discusses the categorization approach.

Table 6. Complex-Level Total Vent and Leak EFs (mt/yr) Calculated from BOEM GEI Data

Pollutant/Facility Subcategory	2005 Complex EF (mt/yr)	2008 Complex EF (mt/yr)	2011 Complex EF (mt/yr)	2014 Complex EF (mt/yr)	2017 Complex EF (mt/yr)
CH_4					
Gas / Major	89	262	123	116	192
Oil / Major	183	281	263	250	250
Gas / Minor	37	10	11	35	25
Oil / Minor	66	15	13	31	38

Pollutant/Facility Subcategory	2005 Complex EF (mt/yr)	2008 Complex EF (mt/yr)	2011 Complex EF (mt/yr)	2014 Complex EF (mt/yr)	2017 Complex EF (mt/yr)
CO_2					
Gas / Major	0.7	2.9	2.0	1.4	6.2
Oil / Major	2.2	3.1	4.2	4.3	3.6
Gas / Minor	0.1	0.1	0.4	0.7	0.2
Oil / Minor	0.5	0.2	0.2	0.4	0.4

Table 7. Complex-Level Vent and Leak CH_4 EFs by Emission Source for Major Sources (mt/yr) Calculated from BOEM GEI Data

Facility Subcategory	Emission Source	Complex CH_4 EF (mt/yr)				
		2005	2008	2011	2014	2017
Gas / Major	**Total**	**89**	**262**	**123**	**116**	**192**
Gas / Major	Cold Vent	17.5	178.9	43.8	29.4	65.5
Gas / Major	Equipment Leaks	45.8	41.5	35.2	48.4	52.5
Gas / Major	Pneumatic Pump	7.5	11.8	18.3	22.9	43.4
Gas / Major	Losses from Flashing	0.8	2.2	1.3	1.3	0.5
Gas / Major	Pneumatic Controller	5.4	17.6	15.2	8.2	22.6
Gas / Major	Combustion	8.2	6.0	6.5	4.8	7.0
Gas / Major	Glycol Dehydrator Unit	3.5	3.7	2.3	0.5	0.1
Gas / Major	Storage Tank	--	0.07	0.07	0.08	0.18
Gas / Major	Mud Degassing	0.15	0.05	0.37	--	--
Gas / Major	Minor Surrogate	--	0.11	0.10	0.02	--
Gas / Major	Amine Gas Sweetening Unit	0.01	0.02	0.01	0.0003	0.03
Oil / Major	**Total**	**183**	**281**	**263**	**250**	**250**
Oil / Major	Cold Vent	65.0	133.2	137.3	103.2	101.8
Oil / Major	Equipment Leaks	65.6	66.9	56.5	77.6	71.5
Oil / Major	Pneumatic Pump	8.2	12.9	16.2	37.6	32.8
Oil / Major	Losses from Flashing	21.3	18.1	16.9	9.0	6.4
Oil / Major	Pneumatic Controller	3.6	21.0	12.8	8.4	20.1
Oil / Major	Combustion	13.3	9.5	12.8	10.8	15.5
Oil / Major	Glycol Dehydrator Unit	5.8	18.5	8.7	2.7	0.8
Oil / Major	Storage Tank	--	0.9	1.0	0.9	0.9
Oil / Major	Mud Degassing	0.2	0.2	0.4	0.2	0.1
Oil / Major	Minor Surrogate	--	0.1	0.1	0.01	--
Oil / Major	Amine Gas Sweetening Unit	0.0005	--	0.0005	0.0001	0.0003

"--" means that emissions were not reported for a source.

Table 8. Complex-Level Vent and Leak CO_2 EFs by Emission Source for Major Sources (mt/yr) Calculated from BOEM GEI Data

Facility Subcategory	Emission Source	Complex CO_2 EF (mt/yr)				
		2005	2008	2011	2014	2017
Gas / Major	**Total**	**0.7**	**2.9**	**2.0**	**1.4**	**6.2**
Gas / Major	Cold Vent	0.36	2.24	1.20	0.84	3.35
Gas / Major	Equipment Leaks	--	--	--	--	--
Gas / Major	Pneumatic Pump	0.19	0.29	0.34	0.31	0.78
Gas / Major	Losses from Flashing	0.02	0.05	0.03	0.03	0.01
Gas / Major	Pneumatic Controller	0.13	0.36	0.43	0.20	0.85
Gas / Major	Combustion	--	--	--	--	--

Facility Subcategory	Emission Source	Complex CO_2 EF (mt/yr)				
		2005	2008	2011	2014	2017
Gas / Major	Glycol Dehydrator Unit	--	--	--	--	--
Gas / Major	Storage Tank	--	--	--	--	--
Gas / Major	Mud Degassing	0.0005	0.0002	0.0013	--	--
Gas / Major	Minor Surrogate	--	--	--	--	--
Gas / Major	Amine Gas Sweetening Unit	--	--	--	0.01	1.20
Oil / Major	**Total**	**2.2**	**3.1**	**4.2**	**4.3**	**3.6**
Oil / Major	Cold Vent	1.55	2.10	2.70	1.75	2.36
Oil / Major	Equipment Leaks	--	--	--	--	--
Oil / Major	Pneumatic Pump	0.14	0.23	0.27	1.69	0.63
Oil / Major	Losses from Flashing	0.49	0.41	0.39	0.21	0.15
Oil / Major	Pneumatic Controller	0.08	0.38	0.85	0.69	0.43
Oil / Major	Combustion	--	--	--	--	--
Oil / Major	Glycol Dehydrator Unit	--	--	--	0.0003	--
Oil / Major	Storage Tank	--	--	--	--	--
Oil / Major	Mud Degassing	0.001	0.001	0.001	0.002	0.001
Oil / Major	Minor Surrogate	--	--	--	--	--
Oil / Major	Amine Gas Sweetening Unit	--	--	--	0.01	0.03

"--" means that emissions were not reported for a source.

Table 9. Complex-Level Vent and Leak CH_4 EFs by Emission Source for Minor Sources (mt/yr) Calculated from BOEM GEI Data

Facility Subcategory	Emission Source	Complex CH_4 EF (mt/yr)				
		2005	2008	2011	2014	2017
Gas / Minor	**Total**	**37**	**10**	**11**	**35**	**25**
Gas / Minor	Cold Vent	9.7	1.1	5.3	2.7	5.6
Gas / Minor	Equipment Leaks	20.4	3.9	2.2	10.6	12.3
Gas / Minor	Pneumatic Pump	4.0	1.3	1.2	19.0	4.6
Gas / Minor	Losses from Flashing	--	0.2	--	0.04	--
Gas / Minor	Pneumatic Controller	1.8	3.1	1.5	2.4	1.2
Gas / Minor	Combustion	1.0	0.3	0.1	0.2	1.4
Gas / Minor	Glycol Dehydrator Unit	0.5	--	0.03	0.05	0.02
Gas / Minor	Storage Tank	--	0.009	0.001	0.001	--
Gas / Minor	Mud Degassing	0.04	0.01	0.01	--	--
Gas / Minor	Minor Surrogate	--	0.3	0.3	0.01	--
Gas / Minor	Amine Gas Sweetening Unit	--	--	--	--	--
Oil / Minor	**Total**	**66**	**15**	**13**	**31**	**38**
Oil / Minor	Cold Vent	27.1	4.4	6.9	10.0	5.5
Oil / Minor	Equipment Leaks	25.8	4.9	2.7	13.8	14.8
Oil / Minor	Pneumatic Pump	8.7	1.5	1.5	5.0	12.4
Oil / Minor	Losses from Flashing	0.04	2.7	0.05	0.3	0.3
Oil / Minor	Pneumatic Controller	2.1	1.1	0.6	0.9	2.9
Oil / Minor	Combustion	2.4	0.3	0.4	0.4	1.6
Oil / Minor	Glycol Dehydrator Unit	0.03	0.12	0.01	0.001	0.22
Oil / Minor	Storage Tank	--	0.01	0.01	0.004	0.02
Oil / Minor	Mud Degassing	0.30	0.02	0.05	0.05	--
Oil / Minor	Minor Surrogate	--	0.35	0.28	0.04	--
Oil / Minor	Amine Gas Sweetening Unit	--	--	--	--	--

"--" means that emissions were not reported for a source.

Table 10. Complex-Level Vent and Leak CO_2 EFs by Emission Source for Minor Sources (mt/yr) Calculated from BOEM GEI Data

Facility Subcategory	Emission Source	Complex CO_2 EF (mt/yr)				
		2005	2008	2011	2014	2017
Gas / Minor	**Total**	**0.1**	**0.1**	**0.4**	**0.7**	**0.2**
Gas / Minor	Cold Vent	0.03	0.01	0.22	0.07	0.05
Gas / Minor	Equipment Leaks	--	--	--	--	--
Gas / Minor	Pneumatic Pump	0.05	0.03	0.09	0.63	0.10
Gas / Minor	Losses from Flashing	--	0.004	--	0.001	--
Gas / Minor	Pneumatic Controller	0.03	0.03	0.07	0.04	0.03
Gas / Minor	Combustion	--	--	--	--	--
Gas / Minor	Glycol Dehydrator Unit	--	--	--	--	--
Gas / Minor	Storage Tank	--	--	--	--	--
Gas / Minor	Mud Degassing	0.00014	0.00004	0.00003	--	--
Gas / Minor	Minor Surrogate	--	--	--	--	--
Gas / Minor	Amine Gas Sweetening Unit	--	--	--	--	--
Oil / Minor	**Total**	**0.5**	**0.2**	**0.2**	**0.4**	**0.4**
Oil / Minor	Cold Vent	0.26	0.09	0.14	0.24	0.12
Oil / Minor	Equipment Leaks	--	--	--	--	--
Oil / Minor	Pneumatic Pump	0.19	0.04	0.03	0.12	0.22
Oil / Minor	Losses from Flashing	0.001	0.061	0.001	0.008	0.008
Oil / Minor	Pneumatic Controller	0.05	0.02	0.01	0.02	0.09
Oil / Minor	Combustion	--	--	--	--	--
Oil / Minor	Glycol Dehydrator Unit	--	--	--	--	--
Oil / Minor	Storage Tank	--	--	--	--	--
Oil / Minor	Mud Degassing	0.0011	0.0001	0.0002	0.0005	--
Oil / Minor	Minor Surrogate	--	--	--	--	--
Oil / Minor	Amine Gas Sweetening Unit	--	--	--	--	--

"--" means that emissions were not reported for a source.

3.2 BOEM Platform Database

This section summarizes the scope and available data from the BOEM Platform Database[13] and how EPA used the data in the updated methodology for the 2020 GHGI.

3.2.1 Scope and Available Data

The BOEM Platform Database provides information on all offshore facilities in GOM federal waters. The information includes complex and structure IDs, lease IDs, Area/Block IDs, install dates, removal dates, the structure water depth, and a major/minor structure designation.[14] There are 7,075 structures and 6,166 complexes in the database; the earliest install date is 1947 and the earliest removal date is 1973. EPA accessed the BOEM Platform Database in March 2020 to conduct the analyses presented in this memo. A similar BOEM dataset is available for facilities in the Pacific, and this information is discussed further in Section 3.6.2.

[13] https://www.data.boem.gov/Platform/PlatformStructures/Default.aspx

[14] A major structure is defined as containing at least 6 completions or containing more than 2 pieces of production equipment.

3.2.2 Considerations for Use in 2020 GHGI Updates

EPA evaluated the BOEM Platform Database to determine the number of active offshore complexes in GOM federal waters, including major versus minor subcategorization (refer to Section 3.1.2.2), in each year of the time series.

An important consideration when determining the number of "active" offshore complexes, versus the number of "existing" offshore complexes, is the removal date. Based on current DOI/Bureau of Safety and Environmental Enforcement (BSEE) regulations, structures must be removed as soon as possible, but no later than 5 years after ceasing production (30 CFR 250.1703(c)). As a result, there can be a period of inactivity (no emissions) while an offshore complex exists but is awaiting or undergoing removal. Because EFs are developed for active (emitting) complexes, EPA aims to exclude inactive complexes from activity data estimates over the time series.

To ensure correct interpretation of the BOEM Platform Database, EPA queried the BOEM Platform Database by various approaches to develop a reasonable assumption for expected decommissioning time (i.e., duration of inactivity before recorded removal date). EPA considered decommissioning time periods ranging from two to four years and found that assuming a three-year decommissioning period produced the most reasonable activity estimates (based on comparing calculated activity from the BOEM Platform Database and GEI reported activity). In other words, EPA considers that a structure or complex is active in year N only if its removal date is three or more years after year N. Figure 11 depicts the major and minor complex counts over the time series, including the split between oil and gas complexes (as discussed in Section 3.3.2 and Section 4.1.2)

3.3 BOEM OGOR-A Production Dataset

This section summarizes the scope and available data from the BOEM OGOR-A dataset and how EPA used the data in the updated methodology for the 2020 GHGI.

3.3.1 Scope and Available Data

BOEM publishes the Oil and Gas Operations Reports – Part A (OGOR-A), that present annual oil and gas production information for each oil and gas lease in GOM federal waters. Two methods to download OGOR-A data are available, and the information in each varies. The complete OGOR-A dataset, which includes production from year 1947 to the present, provides data for each lease ID over this time period.[15] The Area/Block IDs associated with each lease ID are also available, but this information is only available to be downloaded for individual years from 1996 to the present.[16] The GOM federal waters oil and gas production available in OGOR-A is from the offshore facilities whose emissions are estimated in the BOEM GEI. A similar BOEM dataset is available for facilities in the Pacific, and this information is discussed further in Section 3.6.2.

3.3.2 Considerations for Use in 2020 GHGI Updates

EPA used this dataset to assign production type and calculate annual production from all GOM federal water complexes over the time series, as described below.

3.3.2.1 Production Type Assignment

EPA used data on production at the lease-level, Area/Block-level, and Area-level to assign GOM federal water complexes as oil or gas production type (see Section 3.1.2.3). EPA used the complete OGOR-A dataset to analyze lease-level production and the separate individual year OGOR-A downloads to analyze Area/Block-level and Area-level production. EPA applied the existing GHGI methodology to designate each lease, Area/Block, and Area as gas- or oil-production; entities with a GOR greater than 100 mcf/bbl are classified as gas-producing, and entities with a GOR less than 100 mcf/bbl as oil-producing.

[15] See "Production Data" at https://www.data.boem.gov/Main/RawData.aspx.
[16] https://www.data.boem.gov/Main/OGOR-A.aspx

These production type assignments were used in two ways: (1) Matched to the IDs of the offshore complexes in the BOEM GEI data in order to calculate EFs specific to oil and gas complexes (as detailed in Section 3.1.2.3); and (2) Classify the production type fractions of total active GOM federal water complex counts determined from the BOEM Platform Database (see Section 3.2) over the GHGI time series. Figure 4 presents the estimated percentages of active GOM federal water oil versus gas complexes over the GHGI time series.

3.3.2.2 Annual Production

EPA used the complete OGOR-A dataset to determine oil and gas production from oil facilities versus gas facilities over the time series. While OGOR-A production data are reported separately for offshore production from gas wells versus oil wells, EPA used the existing GHGI convention to define each lease with a GOR greater than 100 mcf/bbl as gas-producing, and otherwise defined each lease as oil-producing. The resulting production from oil facilities and gas facilities over the GHGI time series is presented in Figure 5. EPA used the ratio between GOM OCS production and GOM state waters production[17] to estimate offshore production emissions in GOM state waters (see discussion in Section 4.2).

3.4 OGOR-B Flaring and Venting Volumes Dataset

This section summarizes the scope and available data from the BOEM OGOR-B dataset and how EPA used the data in the updated methodology for the 2020 GHGI.

3.4.1 Scope and Available Data

BOEM publishes Oil and Gas Operations Reports – Part B (OGOR-B) that presents lease disposition data, including codes indicating disposal types of flared or vented gas. OGOR-B data are specific to leases in GOM federal waters. As discussed in Section 2.2, in the previous GHGI, CO_2 emissions from all offshore flaring activities were calculated using OGOR-B activity data provided by MMS staff, because the OGOR-B data were not previously publicly available. OGOR-B data are now available online,[18] with limitations: the total combined volume of gas vented and flared is available for all years from 1996 through present, but the separate volumes of gas vented and gas flared have only been available since 2011 (when BOEM expanded reporting requirements).

The publicly available OGOR-B dataset also specifies the volumes of vented and flared gas by well production type (gas versus oil), which facilitated EPA estimating flaring CO_2 emissions separately for natural gas and petroleum systems. Note, while gas and oil wells are not likely defined in the same manner as the GHGI convention (using a GOR threshold of 100 mcf/bbl), this production type designation still likely offers an improvement on the previous methodology which did not separate flaring emissions between natural gas and petroleum systems.

To assess agreement between the previous GHGI basis and the newly available OGOR-B dataset, EPA compared the total volume of gas vented and flared for overlapping years between the publicly available OGOR-B data and data previously provided by MMS staff (years 1996–2008); EPA found that the volumes are very similar, within ±2% in each year—providing support for retaining previous GHGI data in early time series years. The fraction of gas that is flared is not available for overlapping years across the two datasets and therefore could not be directly compared; the data provided by MMS staff are available for 1990–2008, while the publicly available OGOR-B data provide this from 2011 and forward.

The volumes of flared gas used in the previous GHGI (as provided by MMS staff) and the volumes of flared gas reported in the publicly available OGOR-B data are compared in Table 11.

[17] GOM State waters production is available in separate data sources, as discussed in Section 3.6.1.
[18] https://www.data.boem.gov/Main/OGOR-B.aspx

Table 11. Comparison of Flared Gas Volumes for Offshore Production Facilities Between Previous GHGI and OGOR-B

Year	Previous GHGI		OGOR-B				
	Flared & Vented Gas (MMcf)	% Gas Flared	Flared & Vented Gas (MMcf)	% Gas Flared	% of Flared & Vented Gas: from Oil Wells / from Gas Wells	Gas Flared (MMcf)	% of Flared Gas: from Oil Wells / from Gas Wells
1990	13,610	28%	- [b]	- [b]	- [b]	- [b]	- [b]
1991	13,017	28%	- [b]	- [b]	- [b]	- [b]	- [b]
1992	11,193	24%	- [b]	- [b]	- [b]	- [b]	- [b]
1993	11,230	24%	- [b]	- [b]	- [b]	- [b]	- [b]
1994	11,516	24%	- [b]	- [b]	- [b]	- [b]	- [b]
1995	12,537	26%	- [b]	- [b]	- [b]	- [b]	- [b]
1996	14,343	28%	14,630	- [c]	65% / 35%	- [c]	- [c]
1997	15,440	33%	15,749	- [c]	61% / 39%	- [c]	- [c]
1998	16,280	32%	16,497	- [c]	61% / 39%	- [c]	- [c]
1999	14,057	28%	14,057	- [c]	53% / 47%	- [c]	- [c]
2000	12,975	26%	12,992	- [c]	50% / 50%	- [c]	- [c]
2001	13,038	26%	13,060	- [c]	53% / 47%	- [c]	- [c]
2002	12,456	28%	12,470	- [c]	57% / 43%	- [c]	- [c]
2003	10,704	24%	10,704	- [c]	54% / 46%	- [c]	- [c]
2004	10,485	26%	10,423	- [c]	61% / 39%	- [c]	- [c]
2005	9,941	30%	9,895	- [c]	58% / 42%	- [c]	- [c]
2006	8,418	29%	8,433	- [c]	57% / 43%	- [c]	- [c]
2007	8,586	31%	8,474	- [c]	60% / 40%	- [c]	- [c]
2008	11,747	51%	11,871	- [c]	65% / 35%	- [c]	- [c]
2009	- [a]	- [a]	10,396	- [c]	68% / 32%	- [c]	- [c]
2010	- [a]	- [a]	13,009	- [c]	75% / 25%	- [c]	- [c]
2011	- [a]	- [a]	11,182	63%	70% / 30%	7,023	80% / *20%*
2012	- [a]	- [a]	10,646	66%	75% / 25%	7,021	*85% / 15%*
2013	- [a]	- [a]	9,866	56%	73% / 27%	5,555	87% / *13%*
2014	- [a]	- [a]	10,468	56%	75% / 25%	5,899	86% / *14%*
2015	- [a]	- [a]	10,334	63%	81% / 19%	6,528	*91% / 9%*
2016	- [a]	- [a]	9,654	67%	84% / 16%	6,486	*93% / 7%*
2017	- [a]	- [a]	10,163	64%	83% / 17%	6,490	*94% / 6%*
2018	- [a]	- [a]	10,674	66%	86% / 14%	7,014	*95% / 5%*

a – Data from MMS staff were provided for 1990-2008. Year 2008 data were used as surrogate for years 2009 forward in the previous GHGI.

b – OGOR-B does not provide data prior to 1996.

b – OGOR-B does not provide separate vented and flared gas volumes prior to 2011.

3.4.2 Considerations for Use in 2020 GHGI Updates

EPA combined the data used in the previous GHGI (based on historical MMS data) and publicly available OGOR-B datasets to calculate offshore flaring emissions in the updated GHGI. The previous GHGI assigned all offshore flaring emissions to natural gas systems, and the OGOR-B data allowed for a portion of the flaring emissions to be attributed to offshore oil production within petroleum systems in the 2020 GHGI updates.

EPA generally used the previous GHGI data for years 1990-2008 and OGOR-B data for subsequent years. Combining the previous GHGI and OGOR-B datasets required two assumptions to estimate separate natural gas and petroleum offshore flaring emissions over the time series. First, for years 1990 through 2010 (when the percent of flared gas from gas versus oil complexes is not available), EPA applied the year 2011 values (80% of

flared gas is from oil complexes and 20% of flared gas is from gas complexes). Second, the volume of flared gas is not directly available for years 2009 and 2010, and EPA linearly interpolated between the 2008 and 2011 volumes. The resulting flared gas volumes are presented in Figure 6.

EPA also created a consistent approach to calculate flaring CO_2, CH_4, and N_2O emissions and used flared gas volumes to estimate each. The previous GHGI included flaring CH_4 emissions within the EFs shown in Table 1 and did not calculate flaring N_2O emissions. The flaring CO_2 EF is discussed in Section 2.2 (54.7 kg/mmBTU) and EPA applied a CH_4 EF of 0.057 kg/MMBtu and an N_2O EF of 0.00091 kg/MMBtu to the flared gas volumes. The CH_4 and N_2O EFs are used in the BOEM GEI calculation methodology. These EFs were adjusted each year using the natural gas heat content, as discussed in Section 2.2.

OGOR-B data are specific to GOM offshore facilities in federal waters, therefore EPA applied other approaches to estimate offshore flaring emissions for GOM state waters, Pacific, and Alaska regions (see Sections 4.2 and 4.3).

3.5 GHGRP

This section summarizes the scope and available data from EPA's GHGRP dataset and how EPA used the data in the updated methodology for the 2020 GHGI.

3.5.1 Scope and Available Data

Offshore petroleum and natural gas production facilities (referred to as "offshore production facilities" in this memo) are defined in the GHGRP as: *Any platform structure, affixed temporarily or permanently to offshore submerged lands, that houses equipment to extract hydrocarbons from the ocean or lake floor and that processes and/or transfers such hydrocarbons to storage, transport vessels, or onshore. In addition, offshore production includes secondary platform structures connected to the platform structure via walkways, storage tanks associated with the platform structure and floating production and storage offloading equipment (FPSO). This source category does not include reporting of emissions from offshore drilling and exploration that is not conducted on production platforms.* "Offshore" is defined as: *Seaward of the terrestrial borders of the United States, including waters subject to the ebb and flow of the tide, as well as adjacent bays, lakes or other normally standing waters, and extending to the outer boundaries of the jurisdiction and control of the United States under the Outer Continental Shelf Lands Act.*

GHGRP subpart W requires offshore production facilities meeting the reporting threshold (25,000 mt CO_2e) to report CO_2, CH_4, and N_2O emissions from equipment leaks, vented emission, and flare emission source types as identified in the BOEM GEI data collection and emissions estimation study. Offshore production facilities under BOEM jurisdiction report the same annual emissions as calculated and reported in the BOEM GEI; offshore production facilities that are not under BOEM jurisdiction are still required to use the monitoring and calculation methods used in the most recent BOEM GEI publication.

The BOEM GEI study is updated and published triennially (to coincide with the EPA and state agency onshore criteria pollutant inventory process). For any calendar year that does not overlap with the most recent published BOEM GEI study and/or methods, GHGRP reporters must employ the most recently published study estimates or methods, then adjust emissions based on the operating time for the facility relative to operating time in the previous reporting or calculation period.

For fuel combustion emissions, GHGRP offshore production facilities report CO_2, CH_4, and N_2O emissions using methodologies specified in subpart C.

In addition to emissions data, GHGRP offshore production facilities annually report production volumes beginning in RY2015, specifically: (1) total quantity of gas handled at the offshore facility in the calendar year, in thousand

standard cubic feet (mscf), including production volumes and volumes transferred via pipeline from another location; and (2) total quantity of oil and condensate handled at the offshore facility in the calendar year, in barrels (bbl), including production volumes and volumes transferred via pipeline from another location.

Table 12 provides an overview of the GHGRP offshore production and emissions reported for RY2015 through RY2018.

Table 12. GHGRP Offshore Emissions and Production Reporting Overview

Data	2015	2016	2017	2018
# Facilities	133	137	141	142
Gas production (Bscf)	1,355	1,344	1,651	1,613
Oil/condensate production (MMbbl)	506	563	616	638
Subpart W Vent and Leak Emissions				
CH_4 (mt)	69,269	71,917	61,248	70,291
CO_2 (mt)	21,678	55,147	52,688	70,676
N_2O (mt)	0	0	0	0
Subpart W Flare Emissions				
CH_4 (mt)	937	1,106	723	726
CO_2 (mt)	459,434	457,617	355,880	376,010
N_2O (mt)	12	11	6	6
Subpart C Emissions				
CH_4 (mt)	99	98	101	105

3.5.2 Considerations for Use in 2020 GHGI Updates

Due to the reporting threshold, GHGRP data generally reflect less than 10 percent of all U.S. offshore production facilities, though coverage varies by region. Emission factors and assumptions based on GHGRP reporters may not be representative of offshore production facilities that do not report to GHGRP.

Most GHGRP reported activity is centered in the GOM, with reporters also located in the Pacific (off the coast of California) and Cook Inlet regions (southern Alaska).

Most of the offshore facilities reporting in RY2017 are located in federal waters. All reporting facilities in the Pacific are in federal waters, and most (if not all) of the reporting facilities in the GOM are in federal waters; while all reporting facilities in Alaska are located in state waters. While the GHGRP dataset coverage overlaps that of the BOEM GEI (GOM federal waters), the GHGRP provides a unique source of emissions characterization data for the Pacific and Alaska regions.

EPA calculated year-specific EFs on a production basis using available GHGRP data, including three levels subcategorization: (1) region (GOM, Pacific, Alaska); (2) production type (gas, oil); and (3) emission type (vent/leak (including engine exhaust CH_4), and flare). To group GHGRP reporters by production type, EPA applied the standard GHGI approach of assignment by calculating the production GOR in a given year and assigning facilities with a GOR greater than 100 mcf/bbl as gas and otherwise as oil. Table 13 and Table 14 show the production-based EFs calculated from GHGRP data for each region. Note, all offshore GHGRP facilities in the Pacific region were categorized as oil facilities. EPA applied the Pacific and Alaska region EFs in the updated 2020 GHGI calculation methodology, see further discussion in Section 4.3.

Table 13. Year-specific EFs Calculated from GHGRP Data for Offshore Oil Facilities

Region/Emission Type/Pollutant	2015	2016	2017	2018
GOM				
Vent and Leak EFs (mt/MMbbl)				
CH_4	123	120	90	100
CO_2	1.6	1.6	1.9	1.1
Flare EFs (mt/MMbbl)				
CH_4	1.7	1.6	0.7	0.7
CO_2	818	709	471	485
N_2O	0.02	0.02	0.01	0.01
Pacific				
Vent and Leak EFs (mt/MMbbl)				
CH_4	421	283	309	409
CO_2	124	3.0	3.1	4.7
Flare EFs (mt/MMbbl)				
CH_4	0.7	0.6	0.8	0.7
CO_2	1,188	623	821	685
N_2O	0.01	0.01	0.01	0.01
Alaska				
Vent and Leak EFs (mt/MMbbl)				
CH_4	461	468	598	479
CO_2	4.6	4.4	4.0	1.6
Flare EFs (mt/MMbbl)				
CH_4	8.2	6.4	3.0	6.4
CO_2	7,647	6,004	5,919	6,035
N_2O	0.1	0.1	0.1	0.1

Table 14. Year-specific EFs Calculated from GHGRP Data for Offshore Gas Facilities

Region/Emission Type/Pollutant	2015	2016	2017	2018
GOM				
Vent and Leak EFs (mt/Bcf)				
CH_4	9.2	4.5	4.0	3.8
CO_2	40	126	64	82
Flare EFs (mt/Bcf)				
CH_4	0.1	0.5	0.3	0.3
CO_2	29	82	57	50
N_2O	0.0002	0.0003	0.0002	0.0002
Alaska				
Vent and Leak EFs (mt/Bcf)				
CH_4	20	34	25	29
CO_2	0.10	0.01	0.00	0.02
Flare EFs (mt/Bcf)				
CH_4	0.16	0.16	0.004	0.08
CO_2	208	150	177	90
N_2O	0.004	0.003	0.003	0.002

3.6 Other Activity Data

The above sections discuss the extensive data available mainly for offshore facilities in GOM federal waters. This section discusses the activity data available for the other offshore production regions, including GOM state waters, and federal and state waters in the Pacific and Alaska. EPA reviewed available activity data on the basis of both offshore facility counts and production volumes and incorporated the production data into the updated 2020 GHGI methodology.

3.6.1 GOM State Waters Activity Data

Offshore production in GOM state waters occurs in coastal areas off the states of Alabama, Louisiana, and Texas. The Oil and Gas Board of Alabama (AL OGB) provides a list of all wells for the state, including offshore.[19] A map of offshore facilities off of Louisiana is available from the Louisiana Department of Wildlife and Fisheries,[20] and detailed well data are available through the Department of Natural Resources' online database - Strategic Online Natural Resource Information System (SONRIS).[21] The Texas General Lands Office provides GIS files for offshore facilities.[22] These datasets may allow EPA to estimate the number of currently operating offshore facilities in GOM state waters, but it did not appear possible to develop such facility counts over the entire GHGI time series and EPA did not use these data in the 2020 GHGI updates.

EPA also reviewed the production data available for GOM state waters. Each state provides both oil and gas production online, in various forms. The AL OGB considers all offshore production to be from gas wells (based on the aforementioned offshore wells data, wherein all offshore data are labeled as "gas"). [23] The Louisiana Department of Natural Resources and the Texas Railroad Commission report oil and gas production from gas wells and oil wells separately. [24,25] Note, while gas and oil wells in these datasets may not be defined in the same manner as the GHGI convention (using a GOR threshold of 100 mcf/bbl), this production type designation offers an improvement versus assigning all production (and hence emissions) to either natural gas or petroleum systems, or making other assumptions to distinguish between natural gas and petroleum systems production. Limited offshore gas production data for these states are also available from EIA; however, the data are of insufficient detail to fully assess GOM state waters oil production.[26] Each of the state agency datasets provide production data over most of the GHGI time series.

Figure 7 and Figure 8 present the offshore oil and gas production data for GOM state waters. EPA applied the relationship between emissions and production for complexes in the OCS of the GOM to estimate emissions for complexes in state waters of the GOM (see Section 4.2 for further discussion).

3.6.2 Pacific Federal and State Waters Activity Data

Offshore production occurs in federal and state waters off the coast of California (Pacific region). The California State Lands Commission provides information on state water facility counts. There are nine offshore production facilities in state waters; four offshore oil facilities and five artificial islands.[27] Federal waters facilities are under BOEM jurisdiction, and there are 23 active offshore facilities in federal waters of the Pacific based on the BOEM Pacific Platform Database (analogous to the BOEM Platform Database covering GOM activity discussed in Section

[19] https://www.gsa.state.al.us/ogb/wells
[20] http://ldwf.maps.arcgis.com/apps/webappviewer/index.html?id=a71d6758535042dd969114fb6a356888
[21] http://www.sonris.com/
[22] http://www.glo.texas.gov/land/land-management/gis/
[23] https://www.gsa.state.al.us/ogb/production
[24] http://www.dnr.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=206
[25] http://webapps.rrc.state.tx.us/PDQ/generalReportAction.do
[26] http://www.eia.gov/dnav/ng/ng_prod_sum_a_epg0_fgw_mmcf_a.htm
[27] https://www.slc.ca.gov/Info/Oil_Gas.html

3.2).[28] Each of the active federal water facilities was installed prior to 1990 and consists of a single, major structure; there is one federal water facility that was removed in 1994.

Pacific region state waters production data are available from annual reports published by the State Oil and Gas Supervisor in the California Department of Conservation[29] and Pacific region federal waters production data are available from BOEM[30] and EIA.[31,32] For Pacific region federal waters production, EPA used EIA data for 1990–1995 and BOEM data for all subsequent years. EPA also assigned all Pacific federal waters and state waters production to oil facilities (Petroleum Systems segment); data are not available for all years to distinguish between gas and oil facility production, and for the years when this can be determined gas facilities account for a small percent of gas production (from 0%–10%). Figure 9 shows the offshore oil production data for the Pacific region. EPA applied an approach to estimate emissions for the Pacific region that relies on production data in conjunction with GHGRP-based EFs (see Section 4.3 for further discussion).

3.6.3 Alaska State Waters Activity Data

At this time, offshore production occurs only in state waters off the coast of Alaska, as noted in Section 1.2. There are two state waters offshore production regions—the Cook Inlet in the south and Beaufort Sea in the north. The Alaska Oil and Gas Conservation Commission (AOGCC) provides information on state water offshore well counts and production.[33,34]

Figure 10 shows the offshore oil and gas production data for Alaska. The AOGCC dataset includes onshore and offshore; EPA estimated the offshore production by summing the production for the API well IDs that are noted as being offshore within the AOGCC well dataset. EPA applied an approach to estimate offshore production emissions for Alaska that uses production volumes as the activity data component in conjunction with GHGRP-based EFs (see Section 4.3 for further discussion).

4 Updated Methodology and National Emissions Estimates for Offshore Production in the 2020 GHGI

The subsections below discuss the EF and activity data updates implemented in the 2020 GHGI, organized by region, and summarized in Table 15.

Table 15. Approaches for 2020 GHGI Updates, by Offshore Region

Region	Memo Section	EF Basis	Activity Data Basis
GOM federal waters	4.1	BOEM GEI, complex-level emission source EFs	BOEM Platform Database complex counts
GOM state waters	4.2	GOM federal waters production-based EFs	State-specific offshore production data
Pacific federal and state (California) waters	4.3	GHGRP (facilities in Pacific region), production-based EFs	Pacific federal and state offshore production data
Alaska state waters	4.3	GHGRP (facilities in Alaska region), production-based EFs	Alaska state offshore production data

[28] https://www.data.boem.gov/Main/PacificPlatform.aspx
[29] https://www.conservation.ca.gov/dog/pubs_stats/annual_reports/Pages/annual_reports.aspx
[30] https://www.data.boem.gov/Main/PacificProduction.aspx
[31] http://www.eia.gov/dnav/ng/ng_prod_sum_a_epg0_fgw_mmcf_a.htm
[32] http://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_a.htm
[33] http://aogweb.state.ak.us/DataMiner3/Forms/WellList.aspx
[34] http://aogweb.state.ak.us/DataMiner3/Forms/Production.aspx

There is a particular consideration for GHGI updates to offshore production emissions in state waters that applies across regions. EPA understands near-shore offshore production might include minimal offshore processing operations, with the production stream piped or shipped to centralized onshore facilities where most of the production segment processing occurs. However, EPA identified very limited data characterizing emissions and activity for such operations that likely fall within state waters. As described further within this section, EPA therefore developed region-specific, *production-based* EFs from facilities in federal waters and/or reporting to GHGRP (which likely have higher per-facility emissions than facilities in state waters or not reporting to GHGRP), and applied such EFs to production in state waters. This effectively estimates emissions from state waters operations by scaling based on production relative to that in federal waters and/or from GHGRP facilities (refer to Figure 1 for production volumes by region in year 2017). EPA considered an alternative of using a complex-level EF developed from these facilities but believes such an approach might overestimate emissions from state water operations; additionally, state water production data are readily available, while state water active complex counts are not.

4.1 Offshore Production in GOM Federal Waters

This section summarizes the approach implemented in the 2020 GHGI for estimating emissions (EFs multiplied by activity data) from offshore production in GOM Federal waters.

4.1.1 EFs

EPA applied year-specific, emission source EFs at the complex level (i.e., emissions per complex) developed from the BOEM GEI dataset (see Table 6 through Table 8) to estimate vent and leak emissions (including engine exhaust CH_4) over the GHGI time series for major complexes, rather than applying the 2011 BOEM GEI EFs to all time series years as in the previous GHGI (refer to Section 2). EPA specifically developed an approach for major complexes where the BOEM GEI-based EFs for a particular year were 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 were applied to year 2005 only (due to the hurricane season impact, discussed in Section 3.1.1);
- EFs calculated from the 2008 BOEM GEI were applied to 1990 through 2004 and 2006 through 2009;
- EFs calculated from the 2011 BOEM GEI were applied to 2010 through 2012;
- EFs calculated from the 2014 BOEM GEI were applied to 2013 through 2015;
- EFs calculated from the 2017 BOEM GEI were applied to 2016 through 2018.

For minor complexes, EPA applied the 2014 and 2017 BOEM GEI minor complex emission source EFs (see Table 6, Table 9, and Table 10) to estimate vent and leak emissions (including engine exhaust CH_4). This consideration is due to changes in BOEM GEI reporting requirements over time; as discussed in Section 3.1.1, the 2014 GEI is the first year in which emissions from minor source structures are fully accounted for in the GEI. EPA applied 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 2018.

EPA maintained the previous GHGI approach to estimate flaring emissions, wherein EFs on the basis of kg/MMBtu (along with year-specific heat content) were applied to OGOR-B flared gas volumes over the time series—see Sections 2.2 and 3.4.2. While the previous GHGI only estimated flaring CO_2 emissions using this approach, EPA also estimated flaring CH_4 and N_2O emissions using the OGOR-B flaring volumes.

4.1.2 Activity Data

EPA developed an updated approach to estimate active GOM federal waters complex counts to pair with BOEM GEI EFs discussed in Section 4.1.1. As discussed in Section 2.1, the previous GHGI activity data relied on an MMS dataset that had not been updated since 2010, and EPA has recently identified opportunities to improve subcategorization of EFs and thus applicable activity data, based on stakeholder feedback. EPA used the BOEM

Platform Database (discussed in Section 3.2) to count total active complexes, subcategorized by major versus minor complexes over the time series; details of this approach are discussed in Section 3.2.2. EPA then used the BOEM OGOR-A Production Dataset to further subcategorize complexes as gas versus oil production; details of this approach are discussed in Section 3.3.2. Figure 11 presents the resulting complex counts over the time series, compared to the facility counts in the 2019 GHGI.

EPA estimated offshore flared gas volumes over the time series by relying on both the historical activity data provided by MMS staff (used in the previous GHGI) and publicly available OGOR-B data. Details of this approach are discussed in Section 3.4.

4.1.3 Emissions

Figure 12 Figure 13 show the total CH_4 emissions and CO_2 emissions, respectively, for the 2020 GHGI updates for GOM federal water offshore production facilities, compared to the 2019 GHGI emissions (which also solely represent GOM federal water emissions). The updates for the 2020 GHGI for GOM federal water offshore facilities did not change the GOM federal water offshore production CH_4 emissions for petroleum systems in year 2017 and resulted in an average increase of 43% over the 1990-2017 time series (with most of the increase occurring over the 1990-2009 time frame). The updates resulted in an 87% decrease in GOM federal water offshore production CH_4 emissions for natural gas systems in year 2017 and an average decrease of 27% over the 1990-2017 time series. Total CH_4 GOM federal water offshore production emissions decreased by 39% for year 2017 and increased by 11% on average over the 1990-2017 time series for the 2020 GHGI updates compared to the 2019 GHGI. GOM federal waters offshore production total CO_2 emissions increased by 6% for year 2017 and the annual average over the 1990-2017 time series did not change.

4.2 Offshore Production in GOM State Waters

As explained in the introduction to Section 4, EPA understands near-shore offshore production might include minimal offshore processing operations, with the production stream piped or shipped to centralized onshore facilities where most of the production segment processing operations occur. However, EPA identified very limited data characterizing emissions and activity for such operations that likely compose some fraction of activity within state waters. EPA therefore estimated emissions from offshore production in GOM state waters using production-based EFs developed from GOM federal water data, in conjunction with state-specific offshore oil and gas production.

4.2.1 EFs

EPA developed production-based emission source EFs for each year of the time series from the GOM federal waters data. EPA calculated EFs by dividing the GOM federal waters emissions for an emission source by the GOM federal waters production in each year. The production basis was also unique for oil complexes and gas complexes; oil production was used in the numerator for oil complexes and gas production was used in the numerator for gas complexes.

4.2.2 Activity Data

EPA used annual state-specific offshore production (discussed in Section 3.6.1) paired with the EFs discussed in Section 4.2.1 to calculate emissions. Similar to the EF basis, oil production was used for oil complexes and gas production was used for gas complexes.

4.2.3 Emissions

Figure 14 and Figure 15 show the GOM state waters total CH_4 emissions and CO_2 emissions, respectively, for the 2020 GHGI updates.

4.3 Offshore Production in Pacific and Alaska Regions

As explained in the introduction to Section 4, EPA understands there are limitations to the available data for the offshore Pacific and Alaska regions to characterize all offshore production emissions in these regions. However, EPA used reported GHGRP data (refer to Section 3.5) to calculate production-based EFs, to be used in conjunction with region-specific offshore oil and gas production.

4.3.1 EFs

EPA applied the GHGRP production-based EFs shown in Table 13 and Table 14 to estimate emissions from facilities in the Pacific and Alaska regions. The GHGRP RY2015 EFs were applied to all prior years in the GHGI time series. The production basis was also unique for oil complexes and gas complexes; oil production was used in the numerator for oil complexes and gas production was used in the numerator for gas complexes.

4.3.2 Activity Data

EPA used year-specific, region-specific offshore production (discussed in Sections 3.6.2 and 3.6.3) to pair with the EFs discussed in Section 4.3.1 to estimate emissions over the time series. Similar to the EF basis, oil production was used for oil complexes and gas production was used for gas complexes.

4.3.3 Emissions

Figure 16 and Figure 17 show the total CH_4 emissions and CO_2 emissions, respectively, for the 2020 GHGI updates for the Pacific and Alaska regions.

4.4 Emissions Summary

Error! Reference source not found. and Figure 19 show the total offshore production CH_4 emissions and CO_2 emissions, respectively, for the 2020 GHGI updates for each of the production regions, compared to the 2019 GHGI emissions.

For the 2020 GHGI updates, GOM federal waters offshore facilities account for a majority of the offshore production emissions in both petroleum systems (offshore oil facilities) and natural gas systems (offshore gas facilities). For offshore oil production, in year 2017, GOM federal waters offshore facilities account for 91% of CH_4 emissions, 74% of CO_2 emissions, and 72% of N_2O emissions. Alaska region offshore oil facilities contribute 6% of offshore oil production CH_4, 23% CO_2 emissions and 25% of N_2O emissions. Offshore facilities in the Pacific region and in GOM state waters each contribute less than 3% of emissions of CH_4, CO_2, or N_2O from offshore oil production. For offshore gas production, in year 2017, GOM federal waters facilities account for 70% of CH_4 emissions, 64% of CO_2 emissions, and 64% of N_2O emissions. GOM state waters contribute 28% of CH_4 emissions, 26% of CO_2 emissions, and 26% N_2O. Table 16 presents the offshore production CH_4, N_2O, and CO_2 emissions for each region in year 2017 for the 2020 GHGI updates and the 2019 GHGI.

Compared to the 2019 GHGI, petroleum systems offshore production CH_4 emissions increase overall for the 2020 GHGI updates, while natural gas systems offshore production CH_4 emissions decrease overall for the 2020 GHGI updates. Compared to the 2019 GHGI, offshore production CO_2 emissions increase overall for the 2020 GHGI updates. Petroleum systems offshore production flaring CO_2 emissions also constitute approximately 90% of the total flaring CO_2 emissions for the 2020 GHGI updates, whereas the 2019 GHGI assigned all offshore production flaring CO_2 emissions to natural gas systems. The 2019 GHGI did not calculate N_2O emissions, while the 2020 GHGI updates calculated flaring N_2O emissions for each region. Table 17 shows the percent change between the 2019 GHGI and the 2020 GHGI updates, for year 2017 and on average over the 1990-2017 time series.

Table 16. Offshore Production Year 2017 CH_4, CO_2, and N_2O Emissions (mt), by Region, for the 2020 GHGI Updates and the 2019 GHGI

Emissions Category	Region	2020 GHGI Update (Year 2017)	2019 GHGI (Year 2017)
CH_4			
Petroleum systems	GOM Federal Waters	186,806	187,604
	GOM State Waters	1,222	NE
	Alaska	12,164	NE
	Pacific	5,052	NE
	Total	**205,243**	**187,604**
Natural gas systems	GOM Federal Waters	19,563	150,565
	GOM State Waters	7,995	NE
	Alaska	501	NE
	Pacific	n/a	n/a
	Total	**28,060**	**150,565**
CO_2			
Petroleum systems	GOM Federal Waters	379,413	8,340
	GOM State Waters	2,482	NE
	Alaska	119,963	NE
	Pacific	13,440	NE
	Total	**515,299**	**8,340**
Natural gas systems	GOM Federal Waters	24,564	372,116
	GOM State Waters	10,039	NE
	Alaska	3,483	NE
	Pacific	n/a	n/a
	Total	**38,085**	**372,116**
N_2O			
Petroleum systems	GOM Federal Waters	6.25	NE
	GOM State Waters	0.04	NE
	Alaska	2.16	NE
	Pacific	0.24	NE
	Total	**8.68**	NE
Natural gas systems	GOM Federal Waters	0.40	NE
	GOM State Waters	0.16	NE
	Alaska	0.06	NE
	Pacific	n/a	NE
	Total	**0.62**	NE

NE = Not estimated.
n/a = Not applicable.

Table 17. Percent Change Due to Recalculations in CH_4 and CO_2 Emissions Between the 2019 GHGI and the 2020 GHGI Updates

Emissions Category	Year 2017 Change from 2017 Estimate in Previous GHGI	1990-2017 Time Series Average Annual Change from Previous GHGI
CH_4		
Petroleum systems	9%	67%
Natural gas systems	-81%	-14%

Emissions Category	Year 2017 Change from 2017 Estimate in Previous GHGI	1990-2017 Time Series Average Annual Change from Previous GHGI
Total	**-31%**	**31%**
CO_2		
Petroleum systems*	6,079%	7,106%
Natural gas systems	-90%	-71%
Total	**45%**	**184%**

* In the previous (2019) GHGI, all CO_2 emissions from flaring were reported under Natural Gas Systems.

5 Requests for Stakeholder Feedback

EPA sought stakeholder feedback on the approaches under consideration discussed in the September 2019 memorandum. The questions below were not updated for this memorandum and are copied from the September 2019 memorandum. In response to the memo and public review draft emissions for the 2020 GHGI, stakeholders provided feedback on the offshore production approaches, and their feedback is summarized here:

- Stakeholders generally supported the update to offshore oil and gas production emissions calculations, including updating the activity data and EFs.
- Stakeholders suggested clarification on how complexes were assigned to oil and gas production, specifically how to interpret Table 4 in the September 2019 memo. Clarification has been provided in an updated version of Table 4, to emphasize that assigning each complex in the BOEM GEI dataset to oil or gas production was based on data specific to that year (where possible) and that BOEM GEI datasets were not consolidated or combined in any manner when calculating EFs.
- A stakeholder suggested clarification on the data source used to calculate emission factors for each region. Clarification has been provided in Table 15, which identifies whether EFs were based off BOEM GEI or GHGRP data.
- A stakeholder supported considering an approach that would use source-specific emission factors. Additional information on source-specific emission factors calculated from BOEM GEI data are presented in Table 7 through Table 10. Additionally, source-specific emission factors for each region are available in the Annex Excel files.[35]
- A stakeholder expressed concern that the use of emission factors calculated from data from the GHGRP reporting population (those emitting over the GHGRP threshold), applied to all Pacific and Alaska offshore production could skew regional emission estimates. EPA applied the GHGRP EFs for these regions; alternative data sources are unavailable.
- A stakeholder supported the use of GEI data as opposed to OGOR-B data to calculate flaring emissions. This was considered but EPA applied the OGOR-B data because it is more readily available across the full time series. EPA is aware the BOEM GEI studies may be updated more frequently in the future, and will assess the data as it becomes available.
- A stakeholder noted upcoming availability of emissions data for offshore production. This feedback has been noted in the Planned Improvements section of the GHGI.

General

1. EPA seeks stakeholder feedback on the proposed approach of calculating vent and leak EFs that include emissions from all equipment at an offshore facility (except for flares), versus calculating emission source-specific EFs. For consideration, Section 3.1.1 documents the emission sources included in the BOEM GEI-based complex-level vent and leak EFs.

[35] Annexes for the 1990-2018 Inventory are available at https://www.epa.gov/ghgemissions/natural-gas-and-petroleum-systems.

2. The 2020 GHGI updates under consideration show a noticeable decrease in CH_4 emissions over the time series (see Figure 18). EPA seeks feedback on the trend, including information on changes in offshore production practices over time that may have contributed to the trend.

Region-specific Approaches Under Consideration

3. ***GOM Federal Waters***: EPA seeks feedback on the datasets and approach under consideration to estimate offshore production emissions in GOM federal waters using BOEM GEI data. This includes feedback on the following:
    a. The approach to develop complex-level EFs from BOEM GEI data for each subcategory (i.e., oil and gas complexes, major and minor complexes).
    b. The approach for applying the BOEM GEI EFs over the time series, including applying BOEM GEI 2008 EFs to all prior years (except for 2005).
        i. Applying the 2005 GEI EFs to prior years of the time series was not considered due to the hurricane season impact (see Section 3.1.1).
    c. The approach to estimate complex counts over the time series using the BOEM Platform Database and OGOR-A data.
4. ***GOM Federal Waters Flaring:*** EPA seeks feedback on the two approaches under consideration to estimate offshore production flaring emissions in GOM federal waters; applying GEI-based EFs (as shown in Table 7) versus OGOR-B based flaring volumes.
    a. If OGOR-B flaring volume data are used in the update, two options are presented in Section 3.4.2. Option A is used to estimate emissions for this memo, but EPA seeks feedback on the assumptions applied for each option and which option is most appropriate to apply, or whether a different methodology should be applied.
    b. Regarding flaring volumes, EPA notes some discrepancies between GEI and OGOR-B flaring volumes. The GEI flaring volumes (used to calculate the GEI-based EFs) are higher than OGOR-B flaring volumes in certain years but lower in other years, see the following table. EPA seeks stakeholder feedback on these discrepancies.

Year	BOEM GEI Flared Gas Volumes (Bcf)	OGOR-B Flared Gas Volumes (Bcf)
2000	2.5	3.4
2005	5.1	3.0
2008	7.0	6.0
2011	10.0	7.0
2014	5.1	5.9

5. ***GOM State Waters, Pacific, and Alaska Regions***: EPA seeks feedback on the datasets and approaches under consideration to estimate offshore production emissions in these regions, specifically:
    a. GOM state waters emissions estimates relying on GOM federal waters production-based EFs.
    b. How to characterize operations and emissions from offshore production in GOM state waters. As discussed in Section 4, EPA understands near-shore offshore production might include minimal offshore processing operations, with the production stream piped or shipped to centralized onshore facilities where most of the production segment processing occurs. However, EPA identified very limited data characterizing emissions and activity for such operations that likely fall within state waters.
    c. Pacific federal and state waters emission estimates relying on GHGRP production-based EFs.
    d. Alaska state waters emission estimates relying on GHGRP production-based EFs.
    e. Whether data are available for EPA to consider an approach wherein facility counts, rather than production volumes, could be used as the activity basis for emissions estimates in these regions.

Other Considerations

6. EPA seeks stakeholder feedback on the potential utility of using DrillingInfo DI Desktop well-level data to estimate oil and gas production in each offshore production region for each year of the time series (under a scenario wherein production-based EFs were used in GHGI updates). The use of this data source would provide benefits including: (1) consistency with the data source for onshore production volumes underlying current GHGI estimates; (2) data processing efficiency compared to the current approach under consideration that involves mining various individual state datasets. If stakeholder feedback supports such an approach, EPA would develop draft methodologies, compare results to current state dataset-based estimates, and share results with stakeholders for additional consideration.
7. EPA seeks feedback on how to track and estimate emissions from anomalous leak events occurring in offshore producing regions, for example the Cook Inlet underwater gas pipeline rupture that occurred in late 2016/early 2017 and released natural gas for multiple months.
8. EPA seeks stakeholder information on other available or upcoming data related to offshore oil and gas emissions. For example, EPA is aware of a number of measurement studies in the Gulf of Mexico. EPA seeks stakeholder information on how information from these studies may be used to assess or update the GHG Inventory estimates.

Appendix A – Memo Figures

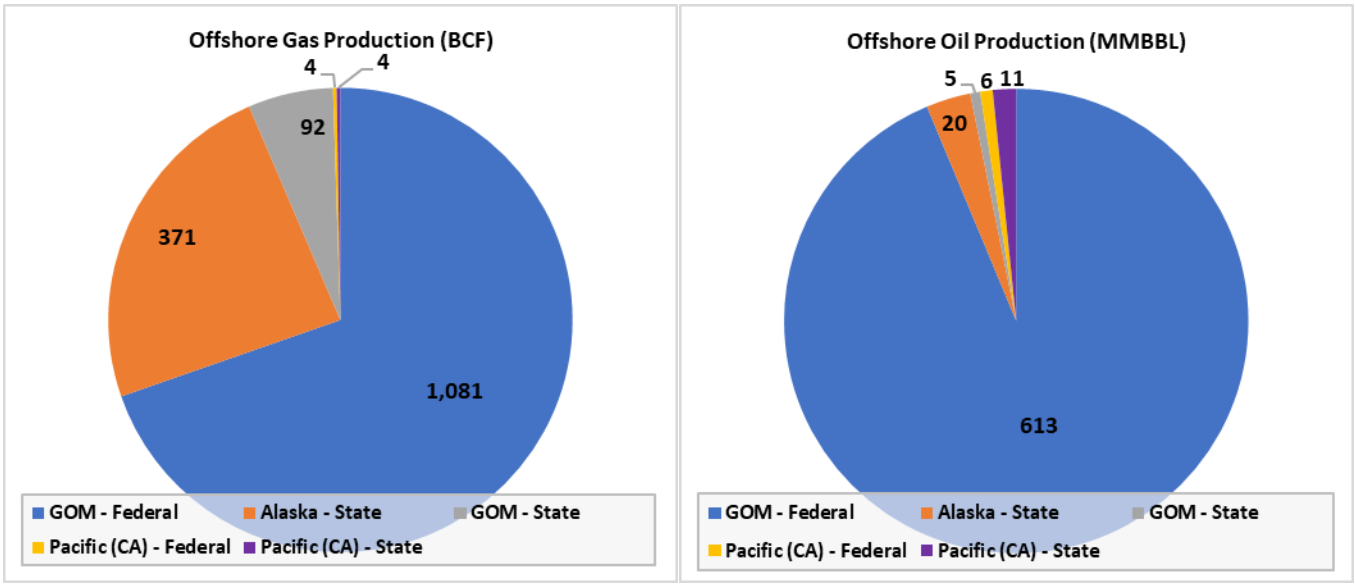

Figure 1. Overview of U.S. Offshore Gas Production (BCF) and Oil Production (MMBBL), Year 2017

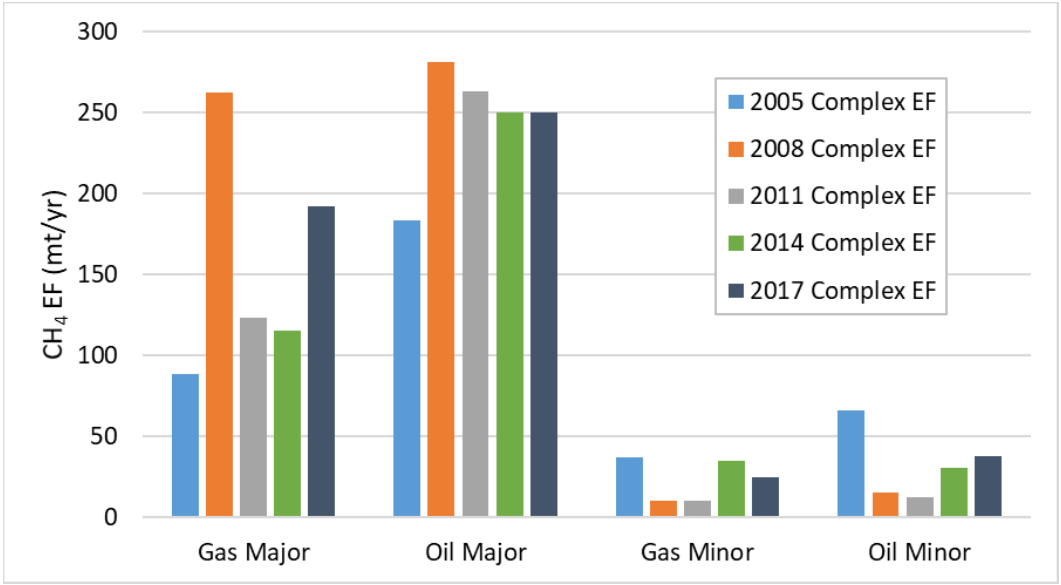

Figure 2. Complex-Level Vent and Leak CH_4 EFs (mt/yr) Calculated from BOEM GEI Data

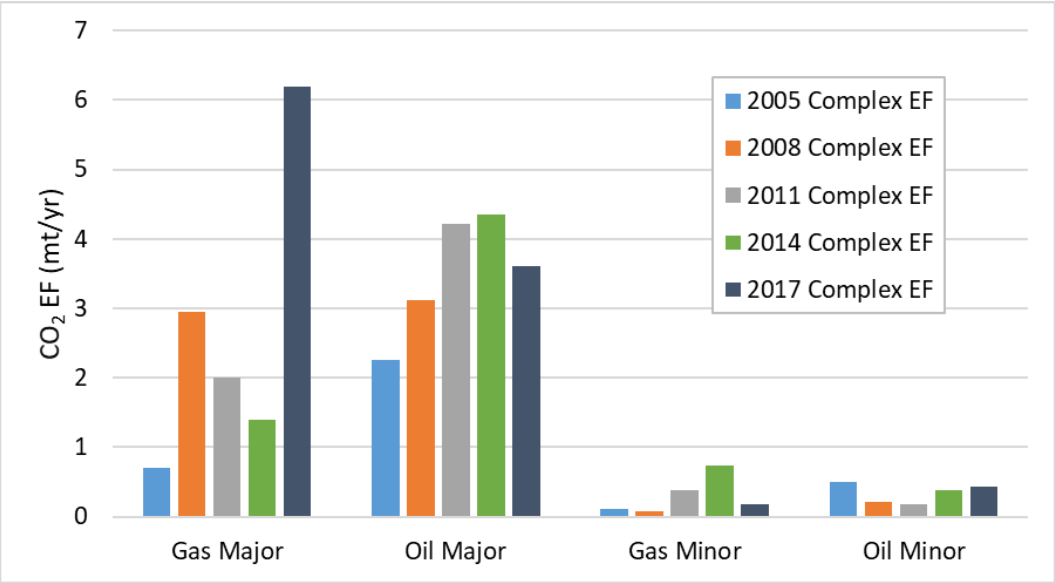

Figure 3. Complex-Level Vent and Leak CO_2 EFs (mt/yr) Calculated from BOEM GEI Data

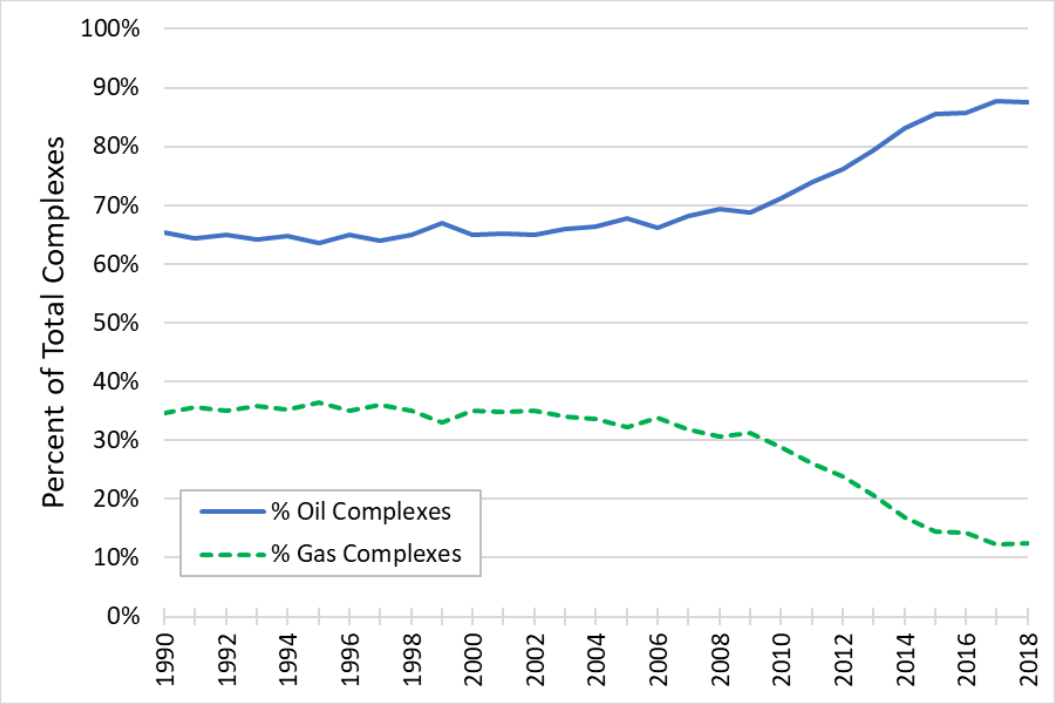

Figure 4. Production Type of Active GOM Federal Water Complexes Over the GHGI Time Series

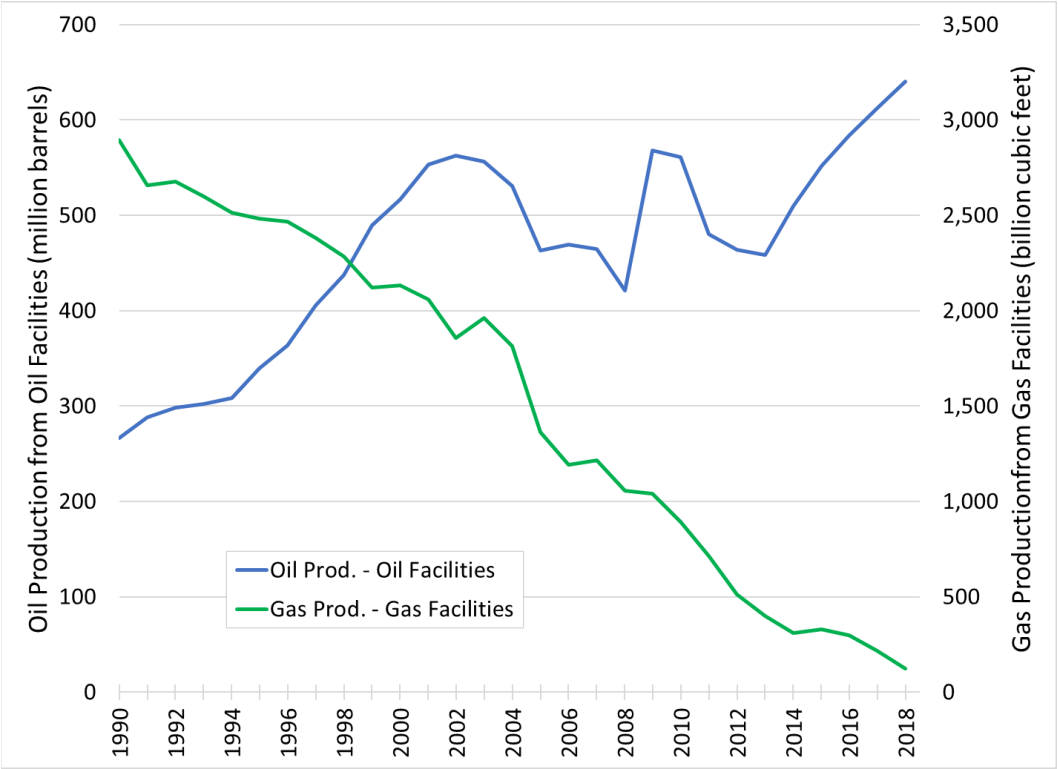

Figure 5. GOM OCS Oil and Gas Production

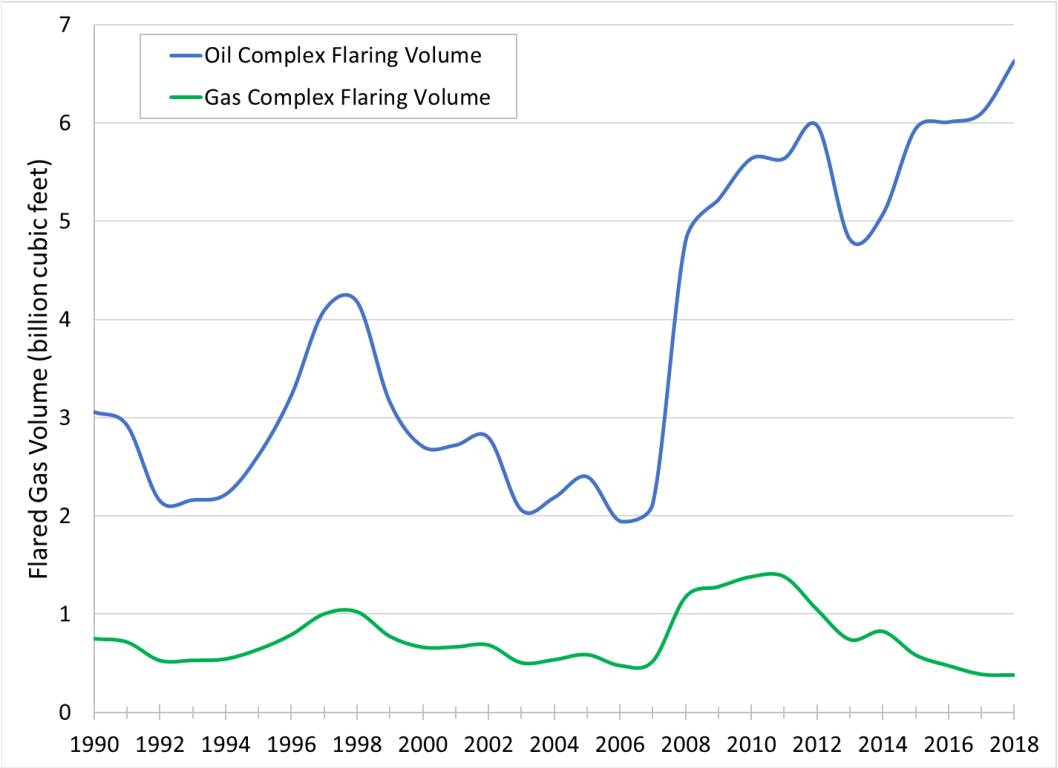

Figure 6. GOM Federal Waters Flared Gas Volumes

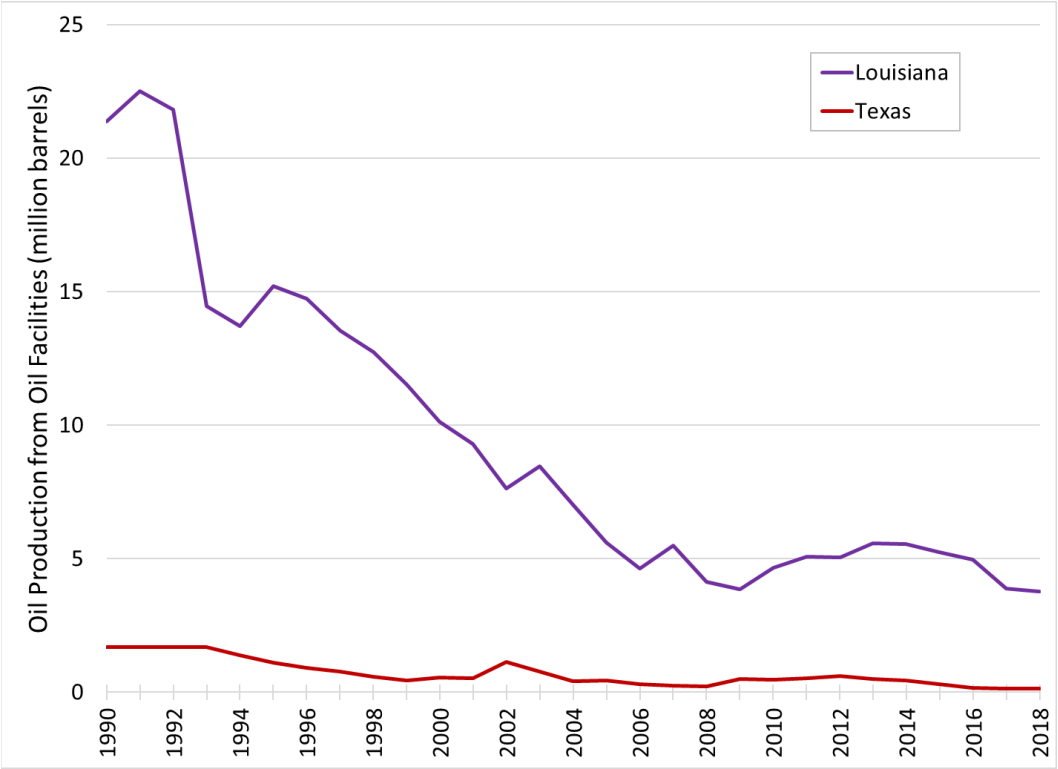

Figure 7. Offshore Oil Production from Oil Facilities in GOM State Waters

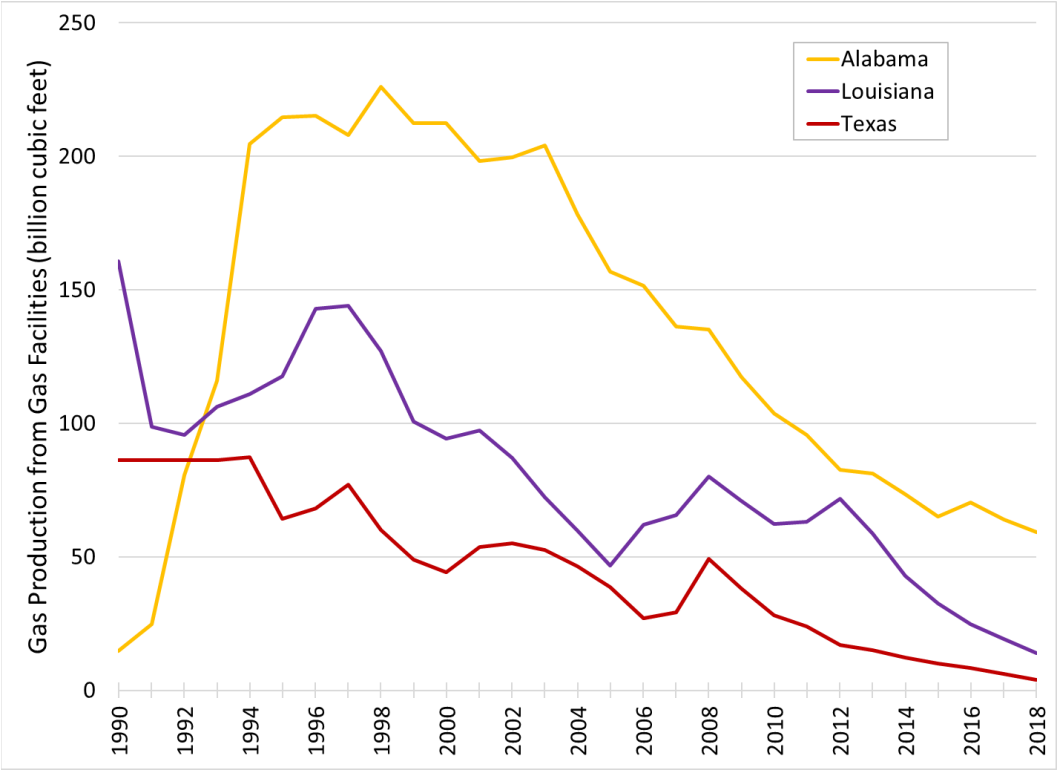

Figure 8. Offshore Gas Production from Gas Facilities in GOM State Waters

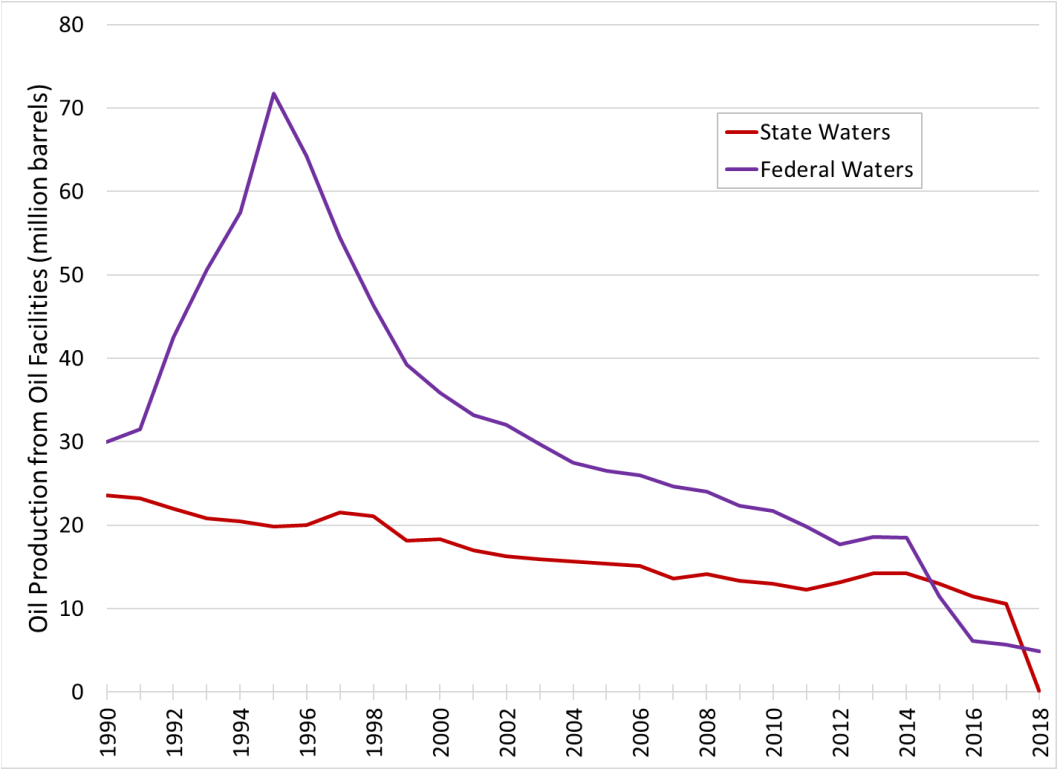

Figure 9. Pacific Federal and State Waters Oil Production from Oil Facilities

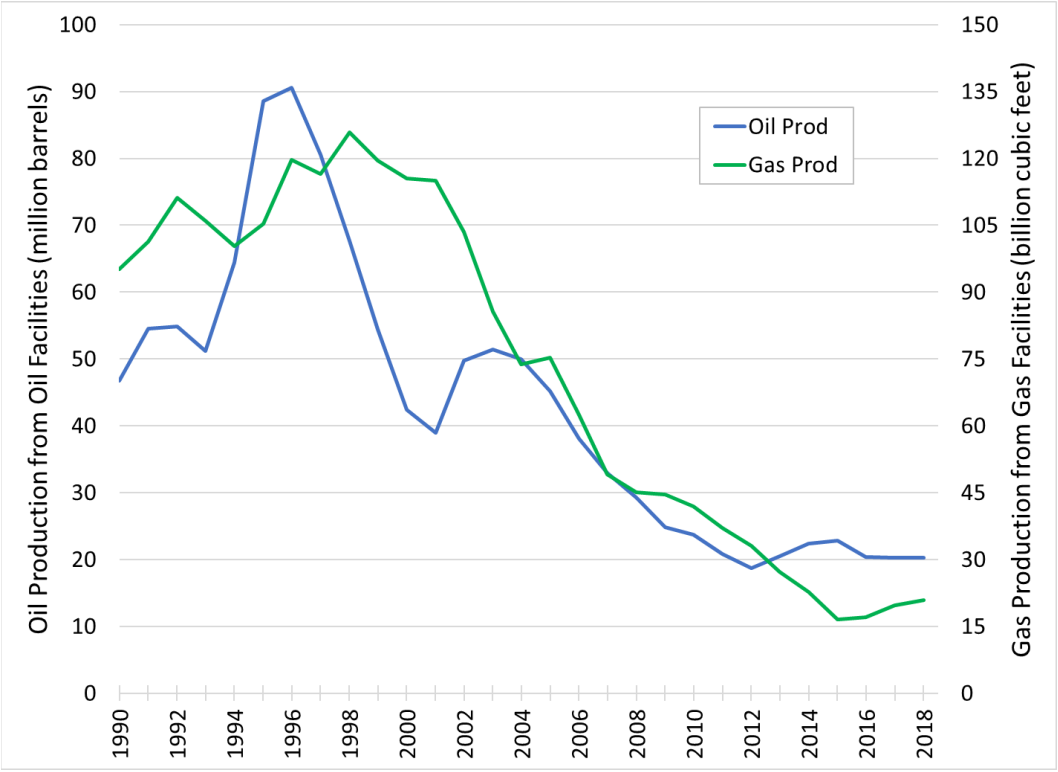

Figure 10. Alaska State Waters Production

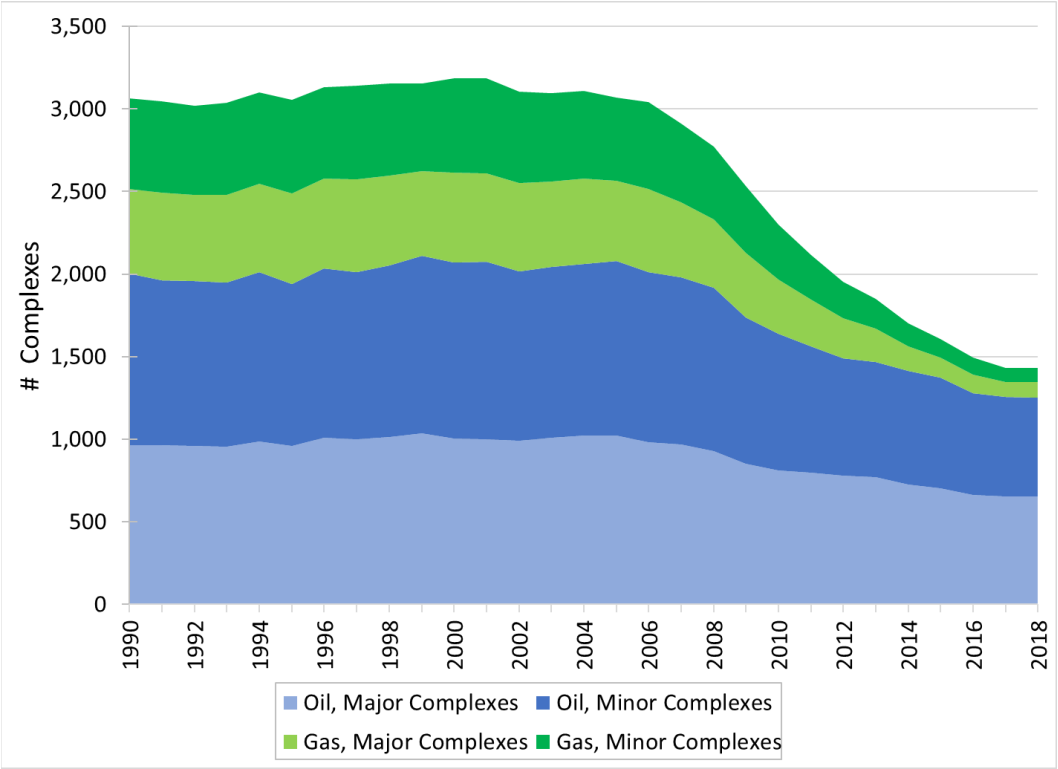

Figure 11. GOM Federal Water Oil and Gas Complex Counts for the 2020 GHGI Updates

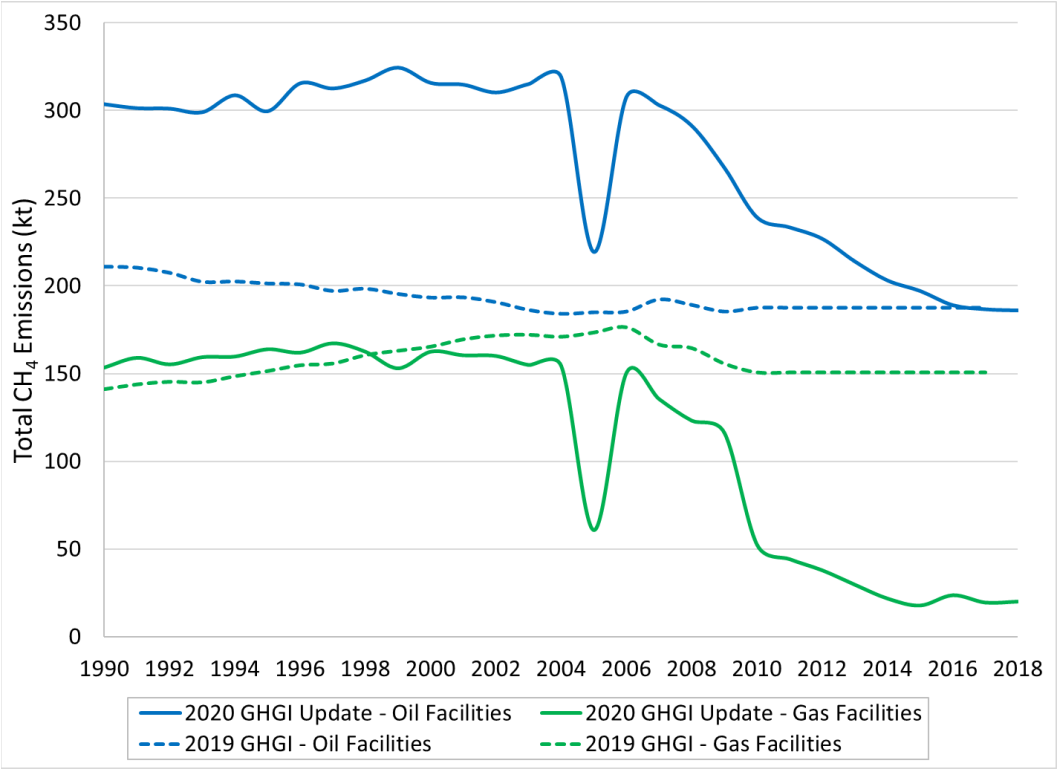

Figure 12. GOM Federal Waters Offshore Production CH_4 Emissions by Production Type (Oil and Gas Facilities) for 2020 GHGI Update Compared to 2019 GHGI Emissions

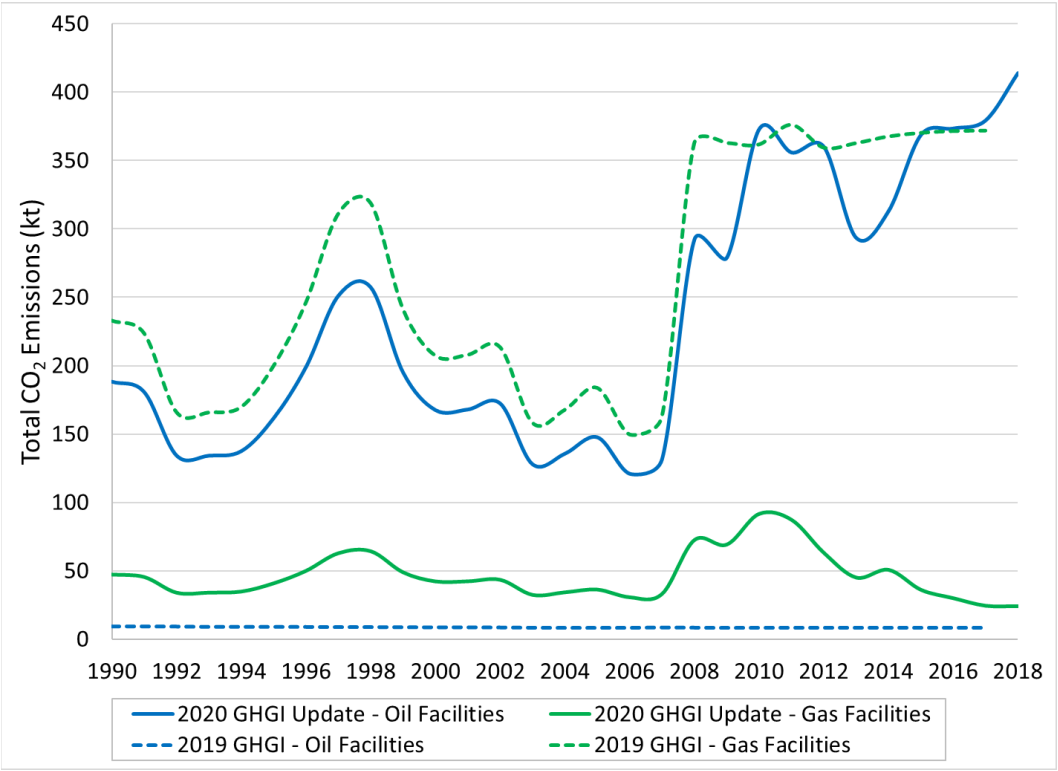

Figure 13. GOM Federal Waters Offshore Production CO_2 Emissions by Production Type (Oil and Gas Facilities) for 2020 GHGI Update Compared to 2019 GHGI Emissions

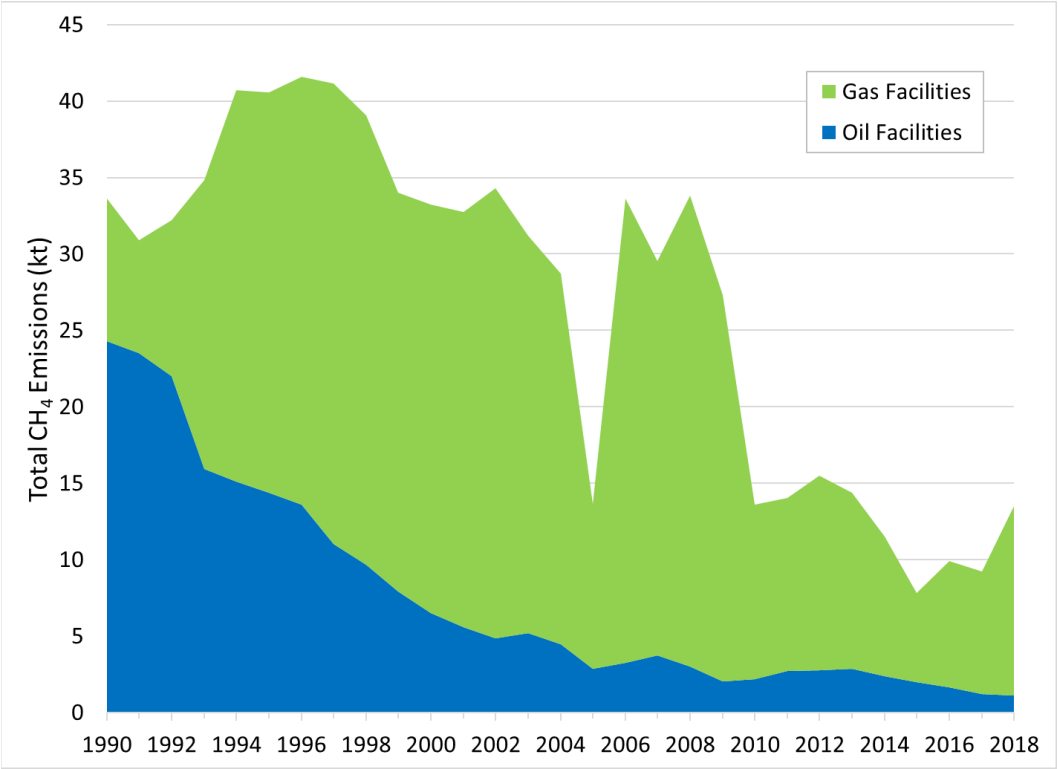

Figure 14. GOM State Waters Offshore Production CH_4 Emissions for 2020 GHGI Update

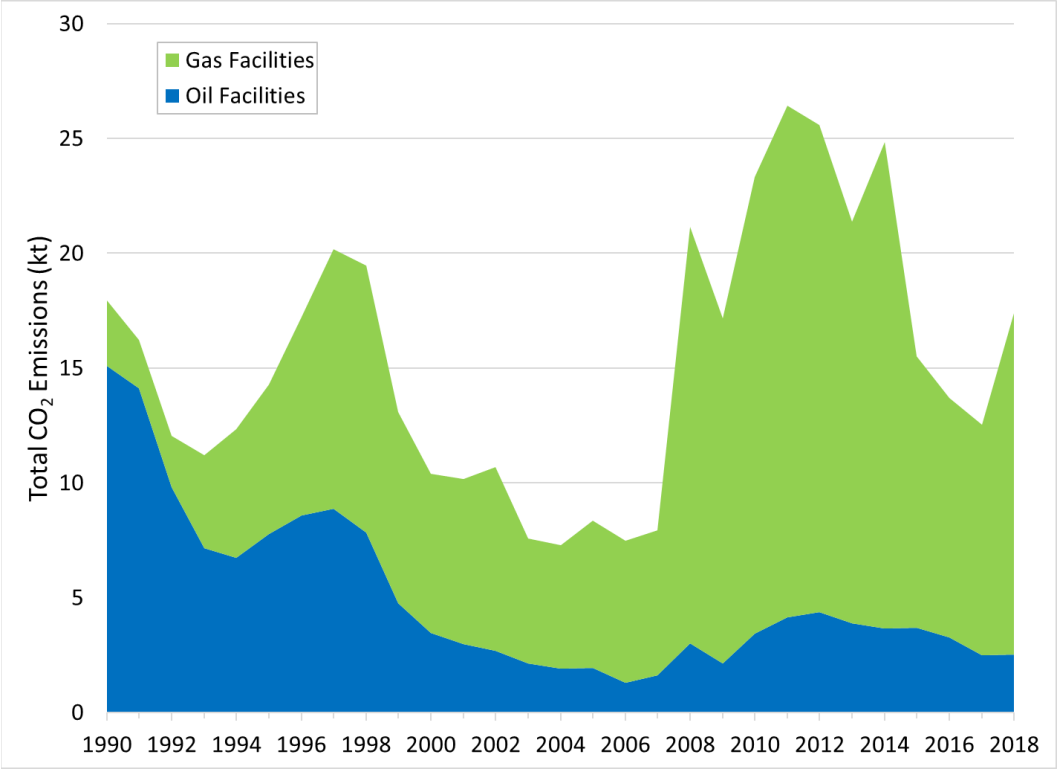

Figure 15. GOM State Waters Offshore Production CO_2 Emissions for 2020 GHGI Update

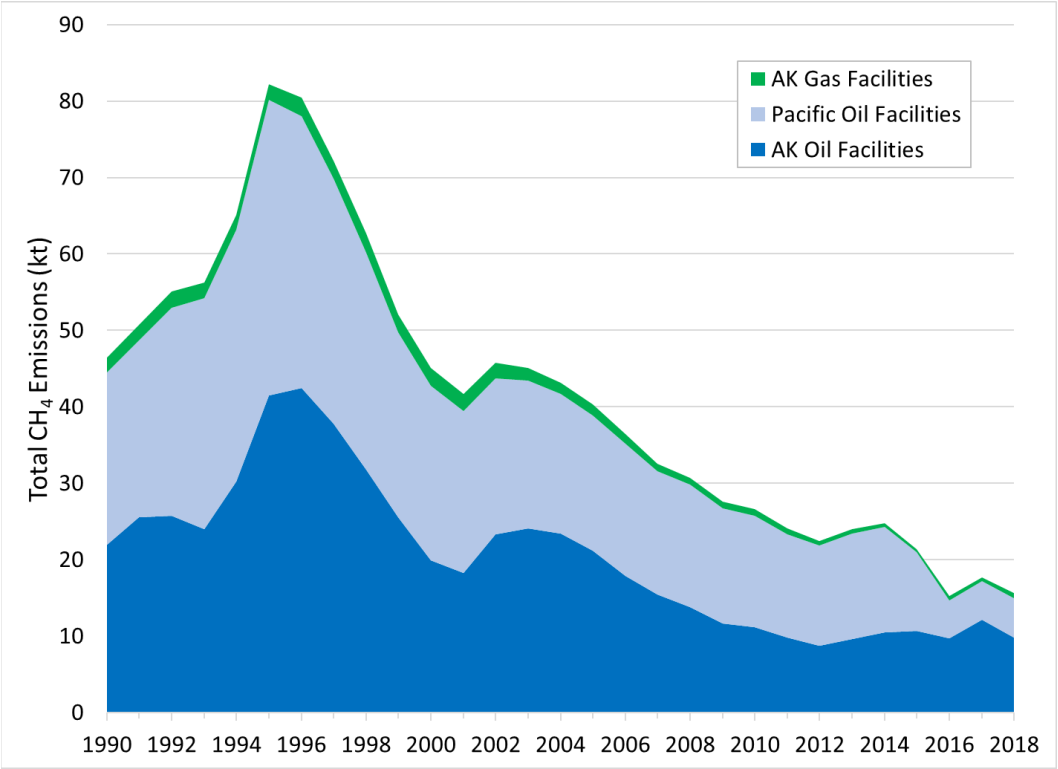

Figure 16. Pacific and Alaska Region Offshore Production CH_4 Emissions for 2020 GHGI Update

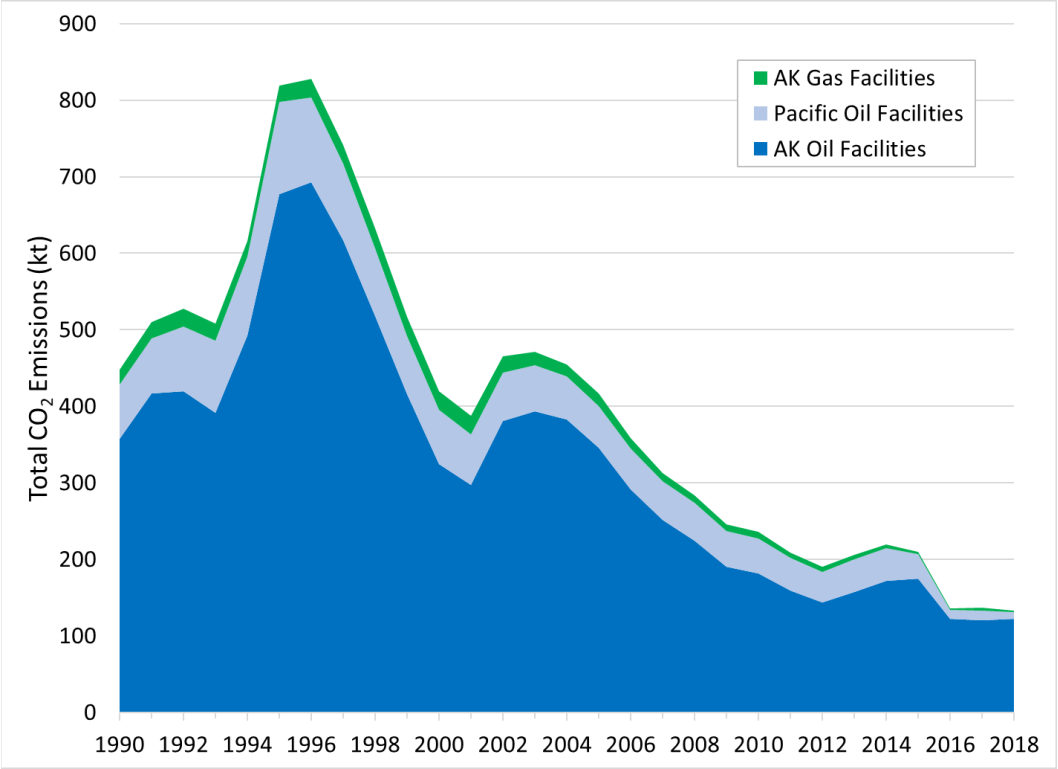

Figure 17. Pacific and Alaska Region Offshore Production CO_2 Emissions for 2020 GHGI Update

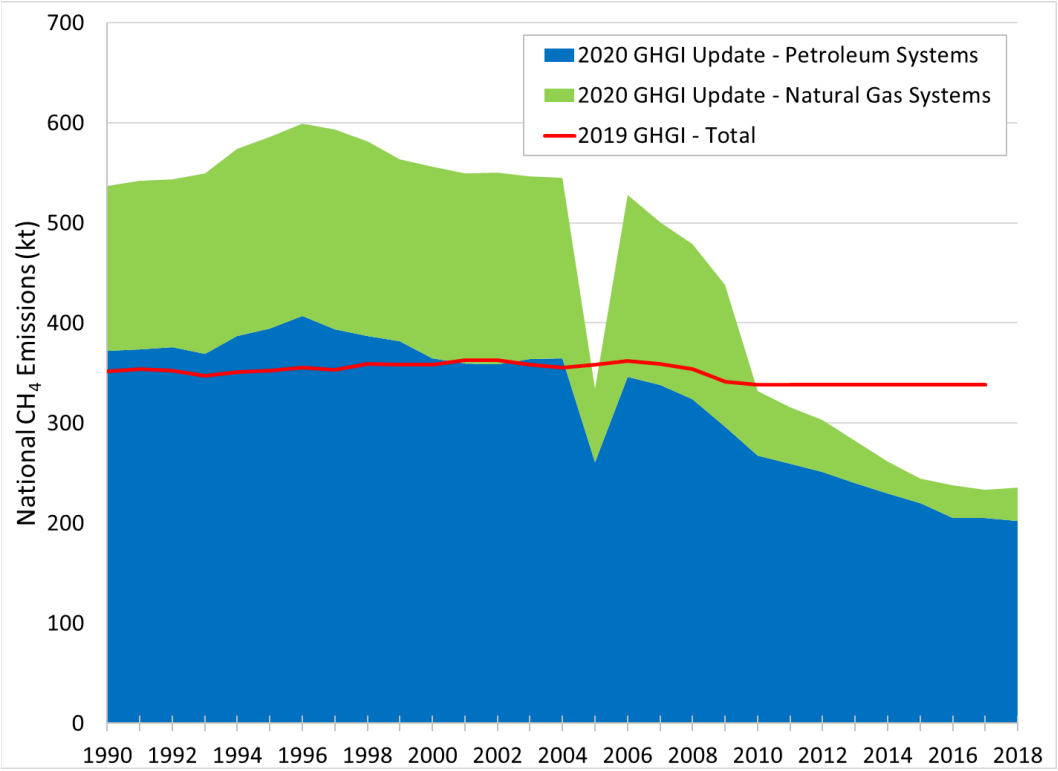

Figure 18. Offshore Production Total CH_4 Emissions For 2020 GHGI Updates Compared to 2019 GHGI Emissions

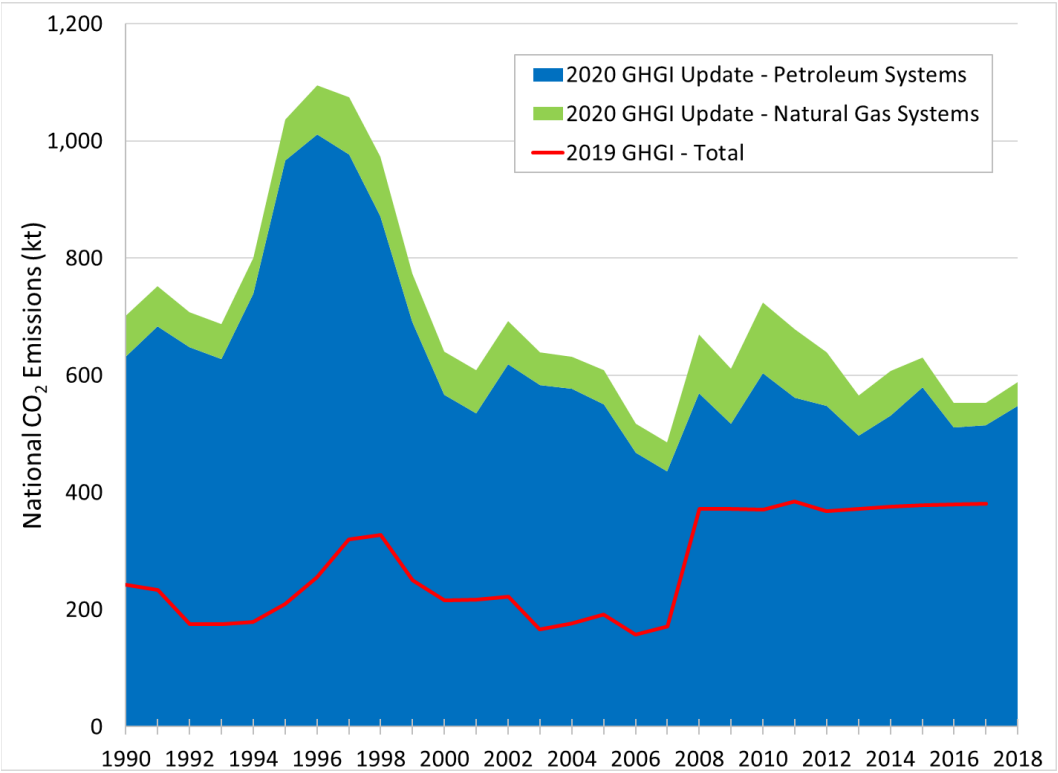

Figure 19. Offshore Production Total CO_2 Emissions For 2020 GHGI Updates Compared to 2019 GHGI Emissions