

## Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2020: Updates Under Consideration for Gas STAR and Methane Challenge Reductions

This memo discusses updates under consideration for the 2022 *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (GHGI) to reassess Natural Gas STAR (“Gas STAR”) reductions and incorporate Methane Challenge reductions. There have been significant updates to the GHGI emission source calculation methodologies in recent years and EPA is assessing Gas STAR data use in the GHGI to ensure that reductions from the program are not double- or undercounted. In addition, EPA is assessing potential use of data from EPA’s Methane Challenge Program.

### 1 Current GHGI Methodology

For a limited number of emission sources within Natural Gas Systems, EPA applies methane (CH<sub>4</sub>) emission factors (EFs) from a 1996 Gas Research Institute (GRI) and EPA study (GRI/EPA study) across the entire 1990-2019 time series.<sup>1</sup> These EFs are representative of technologies and practices in the early 1990’s, but not necessarily of more recent operations. Industry practices and technologies have evolved significantly in the 25 years since the release of the GRI/EPA study. For these emission sources, the current methodology is to calculate emissions by first estimating “potential” emissions with the GRI/EPA factors and then estimating “net” emissions by subtracting voluntary emissions reductions reported under EPA’s Gas STAR program from the potential emissions.<sup>2</sup> Throughout this memo, this is called a “potential methodology”. Most other GHGI emission source calculation methodologies have been updated to use EFs developed from subpart W data or a recently published methane emissions study; throughout this memo, this is called a “net methodology”.

In the current GHGI (i.e., 1990-2019 GHGI), Gas STAR reductions are applied to the following sources:

- Production Segment
  - Gas engines
  - Compressor starts
  - Other (*for activities not assigned to a particular GHGI emission source*)
- Transmission and Storage Segment
  - Pipeline leaks
  - Dehydrator vents (Transmission)
  - Engines (Transmission)
  - Station venting (Transmission)

The most recent Gas STAR reduction data that have been incorporated into the GHGI are for 2013. The 2013 year reductions have been carried forward as proxy data for the 2014 through 2019 emission years without new reductions data being incorporated. Table 1 (Production Segment) and Table 2 (Transmission and Storage Segment) present the numerical Gas STAR reductions used and reported in the current GHGI. Reductions are only presented for inventory years 1990, 2005, and 2015-2019 (i.e., the years shown in the main text of the current GHGI report); Appendix A presents the numerical Gas STAR reductions for the entire 1990-2019 time series in the current GHGI.

---

<sup>1</sup> GRI/EPA 1996. Methane Emissions from the Natural Gas Industry. EPA-600/R-96-080. June 1996.

<sup>2</sup> In addition to adjustments for voluntary reductions, regulatory reductions are also applied for one source in the GHGI--production segment dehydrator vents, to reflect NESHAP reductions. Other sources covered by regulations (such as NSPS) are calculated with a net methodology.

**Table 1. Annual Production Segment Gas STAR Reductions for 1990, 2005, and 2015-2019 (mt CH<sub>4</sub>) in the 2021 GHGI.**

Source	1990	2005	2015	2016	2017	2018	2019
Gas Engines	0	96,625	139,167	139,167	139,167	139,167	139,167
Compressor Starts	0	182	512	512	512	512	512
Other	0	100,762	104,624	104,624	104,624	104,624	104,624
<b>Total</b>	<b>0</b>	<b>197,569</b>	<b>244,304</b>	<b>244,304</b>	<b>244,304</b>	<b>244,304</b>	<b>244,304</b>

**Table 2. Annual Transmission and Storage Segment Gas STAR Reductions for 1990, 2005, and 2015-2019 (mt CH<sub>4</sub>) in the 2021 GHGI.**

Source	1990	2005	2015	2016	2017	2018	2019
Pipeline Leaks	0	0	1,213	1,213	1,213	1,213	1,213
Dehydrator vents	0	2,718	2,819	2,819	2,819	2,819	2,819
Engines	0	83,207	126,910	126,910	126,910	126,910	126,910
Station Venting	0	126,310	136,856	136,856	136,856	136,856	136,856
<b>Total</b>	<b>0</b>	<b>212,235</b>	<b>267,799</b>	<b>267,799</b>	<b>267,799</b>	<b>267,799</b>	<b>267,799</b>

## 2 Background

Early versions of the GHGI relied extensively on the GRI/EPA study, which developed over 80 CH<sub>4</sub> EFs to characterize emissions from various components within the operating stages of the U.S. natural gas system for base year 1992. Because industry practices and technologies have evolved significantly in the 25 years since the release of the GRI/EPA study, and these changes might result in lower emissions for certain equipment and practices, voluntary emissions reductions reported under the Gas STAR program were used to account for these changes within the Natural Gas and Petroleum Systems segments.

The voluntary emission reductions from Gas STAR are classified in that program as either short- or long-term reductions. Short-term reductions are assumed to be 1-year reductions and in the GHGI were only applied to estimated emissions in the specific year of implementation. In contrast, long-term reductions were those reductions for which the reductions extended beyond the specific year of implementation. Most of these long-term reductions were the result of capital investments in new equipment, controls, etc. Gas STAR guidelines assigned a “sunset date”, which is the length of time a technology or practice could continue to accrue emission reductions for the purposes of Gas STAR after implementation. For long-term reductions, the “sunset date” was assumed to be 7 or 10 years. For purposes of the GHGI, EPA assumed that all reported long-term reductions were permanent (i.e., Gas STAR “sunset dates” were ignored and the identified reductions were applied to the implementation year and all subsequent years). The net effect of this assumption was that the total annual quantity of long-term reductions would gradually increase over time as more reductions were reported to Gas STAR.

The mandatory reporting of greenhouse gas emissions for subpart W (Petroleum and Natural Gas Systems) began in 2011. In addition, methane emission studies have also provided recent data to characterize certain emissions sources. As a result, emissions calculation methodologies based on subpart W data and recent methane emission studies have gradually replaced most of the emission source calculation methodologies that had previously used Gas STAR reductions.

## 3 Analysis of Available Data

### 3.1 Gas STAR

EPA obtained the most recent version of the Gas STAR reductions data from the Gas STAR Program, which includes reductions from 1990-2019.<sup>3</sup> For the update under consideration, EPA would replace the Gas STAR data currently used in the GHGI with a revised dataset including the most recent data, adjusted to remove reductions for sources calculated with net methodologies. EPA would treat long-term Gas STAR reductions in the revised dataset in the same manner as the Gas STAR Program (i.e., reductions accrue until the sunset date of either 7 or 10 years) as opposed to the current GHGI approach wherein reductions are assumed to be permanent (see Section 2).

As part of the overall reassessment of the Gas STAR reductions, EPA examined every Gas STAR activity (i.e. the list of technologies and practices implemented by companies to mitigate emissions) in the Production, Transmission and Storage, and Distribution segments.<sup>4</sup> First, EPA assigned each Gas STAR reduction activity in the Production segment and the Transmission and Storage segment to a GHGI emission source; in a few instances, a Gas STAR reduction activity was assigned to two GHGI emissions sources. EPA also assigned relevant Gas STAR reduction activities in the Distribution segment to specific Distribution segment emission sources: pressure relief valve releases, pipe blowdowns, and mishaps (dig-ins). The Gas STAR reductions data assessed included a total of 102 Production segment reduction activities, 58 Transmission and Storage segment reduction activities, and 37 Distribution segment reduction activities.

EPA then assessed which Gas STAR reduction activities were related to a GHGI emission source which still used the “potential methodology” (e.g., the GHGI emission source calculation methodology still relied on data from the 1996 GRI/EPA study) versus the “net methodology” (i.e., the GHGI emission source calculation methodology had been updated to use emissions data from subpart W or a recently published methane emissions study). EPA removed the reduction activities related to a GHGI emission source with a “net methodology” from further analysis. A total of 40 Production segment reduction activities, 23 Transmission and Storage segment reduction activities, and 12 Distribution segment reduction activities were determined to use the “potential methodology”. These activities are presented below in Table 3 (Production Segment), Table 4 (Transmission and Storage Segment), and Table 5 (Distribution Segment). As indicated in the footnotes for Table 3 and Table 4, a few reduction activities were assigned to two GHGI emissions sources for which one source used the “net methodology” and the other source used the “potential methodology”. For these activities, the reductions were adjusted using a ratio of source-specific emissions versus overall emissions. Thus, the reductions from the Production segment reduction activity (i.e., “Capture and use gas released from gas-operated pneumatic pumps”) were reduced by the ratio of Kimray pump emissions to the sum of Kimray pump and chemical injection pump emissions. Likewise, the reductions from the three Transmission and Storage segment reduction activities were reduced using similar ratios.

---

<sup>3</sup> <https://edap.epa.gov/public/extensions/NGS/Accomplishments.html>

<sup>4</sup> EPA did not analyze the Gas STAR activities for the Processing segment as most Processing sources are quantified with net methodologies and we have thus not used Gas STAR reductions for that segment in recent years.

**Table 3. Gas STAR Production Segment Reduction Activities Assigned to GHGI Emission Sources with a Potential Methodology.**

<b>Gas STAR Reduction Activity</b>	<b>GHGI Emission Source</b>
Reduce methane emissions from compressor rod packing systems	Compressors
Automate compressor systems operations to reduce venting	Compressors/Compressor Blowdowns
Lower compressor purge pressure for shutdown	Compressor Blowdowns
Redesign blowdown/alter ESD practices	Compressor Blowdowns
Reduce emissions when taking compressors offline	Compressor Blowdowns
Convert engine starting to nitrogen and/or CO <sub>2</sub> rich gas	Compressor Starts
Convert to low pressure compressor starters	Compressor Starts
Install electric motor starters	Compressor Starts
Reduce gas venting with fewer compressor startups and improved ignition	Compressor Starts
Replace gas starters with air or nitrogen	Compressor Starts
Replace ignition/reduce false starts	Compressor Starts
Install condensers on glycol dehydrators	Dehydrator Vents/Kimray Pumps
Install flash tank separators on glycol dehydrators	Dehydrator Vents/Kimray Pumps
Reduce glycol circulation rates in dehydrators	Dehydrator Vents/Kimray Pumps
Replacing glycol dehydrators with desiccant dehydrators	Dehydrator Vents/Kimray Pumps
Reroute dehydrators/tank vents to flare or station suction	Dehydrator Vents/Kimray Pumps
Reroute glycol skimmer gas	Dehydrator Vents/Kimray Pumps
Shutdown glycol dehydrator stripping gas in winter	Dehydrator Vents/Kimray Pumps
Catalytic converter installation	Engines
Convert natural gas-fired generator to solar power	Engines
Install automated air/fuel ratio controls	Engines
Install electric compressors	Engines
Install electric motors	Engines
Install lean burn compressor	Engines
Install pilotless burner controls	Engines
Turbine fuel use optimization	Engines
DI&M at compressor stations	Equipment Leaks
DI&M at remote sites	Equipment Leaks
DI&M: leak detection using IR camera/optical imaging	Equipment Leaks
DI&M: leak detection using lower emission threshold	Equipment Leaks
DI&M: survey and repair leaks	Equipment Leaks
Install plugs on valves and open ended lines	Equipment Leaks
Test and repair pressure safety valves	Equipment Leaks
Capture and use gas released from gas-operated pneumatic pumps	Kimray Pumps/Chemical Injection Pumps <sup>a</sup>
Convert water tank blanket from natural gas to CO <sub>2</sub>	Produced Water
Install flash tank separator on water gathering system	Produced Water

<sup>a</sup>Kimray pumps use a potential methodology and chemical injection pumps use a net methodology.

**Table 4. Gas STAR Transmission and Storage Segment Reduction Activities Assigned to GHGI Emission Sources with a Potential Methodology.**

Gas STAR Reduction Activity	GHGI Emission Source
Install condensers on glycol dehydrators	Dehydrator Vents
Install flash tank separators/controls on transmission sector glycol dehydrators	Dehydrator Vents
Replace glycol dehydrator with separator and in-line heaters	Dehydrator Vents
Reroute dehydrators/tank vents to flare or station suction	Dehydrator Vents
Reroute glycol skimmer gas	Dehydrator Vents
Install automated air/fuel ratio controls	Engines
Install electric compressors	Engines
Install electric motor starters	Engines
Install electric motors	Engines
Install lean burn compressor	Engines
Replace gas starters with air or nitrogen	Engines
Replace ignition/reduce false starts	Engines
Use of turbines at compressor stations	Engines
DI&M: aerial leak detection using laser and/or infrared technology	Pipeline Leaks
Inspect/repair valves during pipeline replacement	Pipeline Leaks
Pipeline replacement and repair	Pipeline Leaks
Design isolation valves to minimize gas blowdown volumes	Station Venting
Lower compressor purge pressure for shutdown	Station Venting
Move in fire gates at compressors	Station Venting
Reduce emissions when taking compressors offline	Station Venting/Compressors <sup>a</sup>
Inject blowdown gas into low pressure mains or fuel gas system	Station Venting/Pipeline Venting <sup>a</sup>
Redesign blowdown/alter ESD practices	Station Venting/Pipeline Venting <sup>a</sup>

<sup>a</sup> Station venting uses a potential methodology and pipeline venting and compressor emissions are estimated using net methodologies.

**Table 5. Gas STAR Distribution Segment Reduction Activities Assigned to GHGI Emission Sources with a Potential Methodology.**

Gas STAR Reduction Activity	GHGI Emission Source
Install excess flow valves	Mishaps (Dig-ins)
Reduced emissions through third-party damage prevention	Mishaps (Dig-ins)
Inject blowdown gas into low pressure mains or fuel gas system	Pipeline Blowdown
Install overpressure protection system	Pipeline Blowdown
Redesign blowdown/alter ESD practices	Pipeline Blowdown
Reduce/downgrade system pressure	Pipeline Blowdown
Reduce/downgrade system pressure (manual)	Pipeline Blowdown
Use automated systems to reduce pressure	Pipeline Blowdown
Use hot taps for in-service pipeline connections	Pipeline Blowdown
Use pipeline pump-down techniques to lower gas line pressure	Pipeline Blowdown
Test and repair pressure safety valves	Pressure Relief Valve Releases
Test gate station pressure relief valves with nitrogen	Pressure Relief Valve Releases

Tables 6, 7, and 8 present a summary of the year 2019 Gas STAR reductions and GHGI emissions by GHGI emission source (all Gas STAR reductions are summed together for a common GHGI emission source) for the Production segment, the Transmission and Storage segment, and the Distribution segment, respectively. Appendix B presents the complete time series of Gas STAR reductions of each emission source in Tables 6, 7, and 8.

**Table 6. Year 2019 Production Segment Gas STAR Reductions and GHGI Emissions by Emission Source (mt CH<sub>4</sub>).**

GHGI Emission Source	Gas STAR Reductions	GHGI Potential Emissions	GHGI Net Emissions
Compressors	0 <sup>a</sup>	67,025	67,025
Compressor Blowdowns	0 <sup>a</sup>	2,588	2,588
Compressor Starts	1,839	5,790	3,952
Dehydrator Vents/Kimray Pumps	7,104	96,321	89,217
Engines	13,338	251,054	237,716
Equipment Leaks	84	203,137	203,053
Produced Water	0 <sup>a</sup>	187,070	187,070
Total	22,365	812,985	790,620

<sup>a</sup> Gas STAR reductions were not reported for year 2019; however, reductions were reported for other years in the time series.

**Table 7. Year 2019 Transmission and Storage Segment Gas STAR Reductions and GHGI Emissions by Emission Source (mt CH<sub>4</sub>).**

GHGI Emission Source	Gas STAR Reductions	GHGI Potential Emissions	GHGI Net Emissions
Dehydrator Vents	1,330	2,527	1,197
Engines	80,067	286,961	206,894
Pipeline Leaks	590	3,302	2,712
Station Venting	19,312	184,404	165,092
Total	101,299	477,194	375,895

**Table 8. Year 2019 Distribution Segment Gas STAR Reductions and GHGI Emissions by Emission Source (mt CH<sub>4</sub>).**

GHGI Emission Source	Gas STAR Reductions	Methane Challenge Reductions	GHGI Potential Emissions	GHGI Net Emissions
Pressure Relief Valve Releases	0 <sup>a</sup>	47	1,268	1,221
Pipeline Blowdowns	748	192	4,445	3,505
Mishaps (Dig-ins)	828	0	69,287	68,459
Total	1,576	239	75,000	73,185

<sup>a</sup> Gas STAR reductions were not reported for pressure relief valve releases in year 2019; however, reductions were reported for other years in the time series.

### 3.2 Methane Challenge

EPA's Methane Challenge Program has collected reductions data starting with reductions reported for 2016. EPA is considering incorporation of these data into the GHGI.

Methane Challenge data are available for two commitment options (Best Management Practice Commitment Option (BMP) and the ONE Future Emissions Intensity Commitment Option [ONE Future]) and reductions for

both commitment options are considered. BMP partners make a commitment to implement mitigation activities for specific emission sources and the list of emission sources varies by industry segment. ONE Future partners made a commitment to achieve a ONE Future-defined target segment intensity rate by 2025 for all their operations in the segment and may implement mitigation activities for any of their emission sources to achieve that rate. For both options, partners report the emissions reductions achieved in a given year as a result of implementing specific mitigation activities to achieve their commitment. BMP emissions reductions are available for years 2016-2019 and ONE Future emissions reductions are available for years 2017-2019.<sup>5</sup> Compared to the Gas STAR Program, Methane Challenge has fewer reported activities and these activities are reported by emission sources that correspond with GHGI emission sources. Table 9 presents the Methane Challenge reductions by industry segment and emission source for 2016-2019. Table 9 also shows the Methane Challenge emission sources that are related to GHGI emission sources with a potential methodology.

**Table 9. Methane Challenge CH<sub>4</sub> Emission Reductions by Emission Source (mt CH<sub>4</sub>) and Identification of Sources That Use a Potential Methodology.**

Methane Challenge Emission Source	2016	2017	2018	2019	GHGI Emission Source Uses a Potential Methodology?
<b>Transmission Segment</b>					
Transmission Pipeline Blowdowns	4,787	58,113	98,147	74,971	No
Equipment Leaks [transmission station leaks]	0	3,411	8,314	15,118	No
Reciprocating Compressors	0	621	583	911	No
Pneumatic Controllers	0	6	184	215	No
<b>Distribution Segment</b>					
Distribution Mains	2,449	8,974	8,709	9,652	No
Distribution Services	1,014	3,126	2,528	2,682	No
Distribution Pipeline Blowdowns	0	4	802	192	Yes
Pressure Relief Valves	0	789	52	47	Yes
<b>Onshore Production</b>					
Storage Tanks	0	0	0	14	No
<b>Gathering and Boosting</b>					
Reciprocating Compressors	0	0	0	196	No

Only two sources with Methane Challenge reductions use a potential methodology in the GHGI and both are in the distribution segment. For 2016-2019 in the current GHGI, distribution pipeline blowdown emissions average 4,400 mt CH<sub>4</sub> and pressure relief valve releases average 1,300 mt CH<sub>4</sub>.

## 4 Time Series Considerations

Gas STAR reductions are available over the entire time series. Methane Challenge data are available for the year 2016 forward. EPA would consider applying the reductions data only to the years in which it is reported and not make adjustments to earlier years of the time series.

<sup>5</sup> <https://www.epa.gov/natural-gas-star-program/methane-challenge-program-accomplishments>

## 5 Preliminary National Emissions Estimates

EPA used the reductions data presented in Tables 6, 7, and 8 to assess the impact of the update under consideration to replace the existing Gas STAR data with updated information from Gas STAR and Methane Challenge. Tables 10, 11, and 12 compare the year 2019 net emissions for the current GHGI and the update under consideration for the Production, Transmission and Storage, and Distribution segments.

**Table 10. Year 2019 Production Segment Potential and Net Emissions with Existing and Proposed Reductions (mt CH<sub>4</sub>).**

Parameter	Emissions/Reductions
Potential Emissions (Current GHGI)	3,992,187
Gas STAR Reductions (Current GHGI)	244,304
Gas STAR Reductions (Under Consideration)	22,365
Net Emissions (Current GHGI)	3,747,883
Net Emissions (Under Consideration)	3,969,822

**Table 11. Year 2019 Transmission and Storage Segment Potential and Net Emissions with Existing and Proposed Reductions (mt CH<sub>4</sub>).**

Parameter	Emissions/Reductions
Potential Emissions (Current GHGI)	1,746,133
Gas STAR Reductions (Current GHGI)	267,799
Gas STAR Reductions (Under Consideration)	101,299
Net Emissions (Current GHGI)	1,478,334
Net Emissions (Under Consideration)	1,644,834

**Table 12. Year 2019 Distribution Segment Potential and Net Emissions with Existing and Proposed Reductions (mt CH<sub>4</sub>).**

Parameter	Emissions/Reductions
Potential Emissions (Current GHGI)	559,880
Gas STAR Reductions (Current GHGI)	0
Gas STAR Reductions (Under Consideration)	1,576
Methane Challenge Reductions (Under Consideration)	239
Net Emissions (Current GHGI)	559,880
Net Emissions (Under Consideration)	558,065

## 6 Requests for Stakeholder Feedback

EPA seeks stakeholder feedback on the update under consideration discussed in this memo and the questions below.

1. Are the Gas STAR reduction activity assignments to GHGI emission sources in Tables 3 - 5 appropriate?
2. Are there any Gas STAR activities identified in Tables 3 - 5 as having a potential methodology that should be considered to have a net methodology?
3. Are there other data sources available to quantify emissions or reductions for the identified sources?



## Appendix A. Current GHGI Gas STAR Reductions

### A-1. Current GHGI Annual Production Segment Gas STAR Reductions for 1990-2019 (mt CH<sub>4</sub>).

GHGI Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gas Engines	0	0	0	3,217	6,845	12,456	20,855	28,958	34,950	43,414
Compressor Starts	0	0	0	0	0	3	5	6	117	117
Other	0	0	0	5,562	20,524	29,361	59,362	60,621	75,855	81,560
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>8,778</b>	<b>27,369</b>	<b>41,820</b>	<b>80,222</b>	<b>89,586</b>	<b>110,922</b>	<b>125,091</b>

GHGI Source	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Gas Engines	51,862	60,473	69,101	74,801	87,824	96,625	103,170	110,329	115,060	121,762
Compressor Starts	117	179	179	179	182	182	182	189	197	395
Other	76,656	83,116	77,643	95,796	99,957	100,762	93,875	98,577	107,160	102,361
<b>Total</b>	<b>128,635</b>	<b>143,768</b>	<b>146,923</b>	<b>170,777</b>	<b>187,962</b>	<b>197,569</b>	<b>197,226</b>	<b>209,096</b>	<b>222,417</b>	<b>224,517</b>

GHGI Source	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Gas Engines	132,021	135,866	138,672	139,167	139,167	139,167	139,167	139,167	139,167	139,167
Compressor Starts	512	512	512	512	512	512	512	512	512	512
Other	104,184	99,639	99,772	104,624	104,624	104,624	104,624	104,624	104,624	104,624
<b>Total</b>	<b>236,718</b>	<b>236,017</b>	<b>238,956</b>	<b>244,304</b>	<b>244,304</b>	<b>244,304</b>	<b>244,304</b>	<b>244,304</b>	<b>244,304</b>	<b>244,304</b>

### A-2. Current GHGI Annual Transmission and Storage Segment Gas STAR Reductions for 1990-2019 (mt CH<sub>4</sub>).

GHGI Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Pipeline Leaks	0	0	0	0	0	33	0	0	0	0
Dehydrator vents (Transmission)	0	0	0	0	0	0	755	3,249	3,225	3,182
Engines (Transmission)	0	0	0	2,803	7,725	12,547	15,909	19,339	40,719	45,526
Station Venting (Transmission)	0	0	0	2,740	1,416	5,161	7,239	23,627	42,847	58,878
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>5,543</b>	<b>9,141</b>	<b>17,742</b>	<b>23,904</b>	<b>46,215</b>	<b>86,790</b>	<b>107,586</b>

GHGI Source	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Pipeline Leaks	0	0	0	0	0	0	0	0	0	1,136
Dehydrator vents (Transmission)	2,718	2,718	2,718	2,718	2,718	2,718	2,840	2,819	2,819	2,819
Engines (Transmission)	49,291	54,241	68,381	72,424	77,975	83,207	87,797	94,454	103,082	116,170
Station Venting (Transmission)	77,530	106,355	119,998	125,039	127,850	126,310	146,461	129,026	161,055	136,592
<b>Total</b>	<b>129,539</b>	<b>163,313</b>	<b>191,098</b>	<b>200,181</b>	<b>208,543</b>	<b>212,235</b>	<b>237,097</b>	<b>226,299</b>	<b>266,956</b>	<b>256,718</b>

<b>GHGI Source</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
Pipeline Leaks	0	2,773	4,199	1,213	1,213	1,213	1,213	1,213	1,213	1,213
Dehydrator vents (Transmission)	2,819	2,819	2,819	2,819	2,819	2,819	2,819	2,819	2,819	2,819
Engines (Transmission)	119,382	121,688	124,050	126,910	126,910	126,910	126,910	126,910	126,910	126,910
Station Venting (Transmission)	135,250	134,419	135,824	136,856	136,856	136,856	136,856	136,856	136,856	136,856
<b>Total</b>	<b>257,451</b>	<b>261,700</b>	<b>266,891</b>	<b>267,799</b>	<b>267,799</b>	<b>267,799</b>	<b>267,799</b>	<b>267,799</b>	<b>267,799</b>	<b>267,799</b>

## Appendix B. Gas STAR Reductions for the Update Under Consideration

**B-1. Annual Production Segment Gas STAR Reductions, by GHGI Emission Source, for 1990-2019 (mt CH<sub>4</sub>).**

GHGI Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Compressors	0	0	0	0	0	0	0	0	0	0
Compressor Blowdowns	0	0	0	46	61	94	94	95	95	103
Compressor Starts	0	0	0	391	6,891	6,893	9,939	12,705	12,893	12,816
Dehydrator Vents/Kimray Pumps	0	0	0	3,766	5,051	6,862	12,391	20,007	22,938	22,769
Engines	0	0	0	3,037	3,847	5,831	8,618	8,323	6,259	9,123
Equipment Leaks	0	0	0	0	9	250	594	790	9,678	14,378
Produced Water	0	0	0	0	0	0	0	0	0	0
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>7,240</b>	<b>15,858</b>	<b>19,931</b>	<b>31,636</b>	<b>41,920</b>	<b>51,864</b>	<b>59,189</b>

GHGI Source	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Compressors	0	0	0	0	0	2,790	0	0	239	895
Compressor Blowdowns	113	3,804	4,097	9,057	513	479	479	1,486	1,527	2,096
Compressor Starts	12,833	13,030	13,116	12,727	6,816	7,376	4,406	1,673	4,889	2,600
Dehydrator Vents/Kimray Pumps	23,084	26,545	23,545	26,865	27,407	29,660	32,214	34,121	45,314	49,379
Engines	9,498	9,579	10,261	7,708	15,708	12,029	13,179	18,382	16,986	19,423
Equipment Leaks	8,117	9,082	9,097	22,792	24,792	20,118	29,246	23,927	42,160	39,415
Produced Water	628	628	628	628	628	628	686	1,023	1,023	1,023
<b>Total</b>	<b>54,273</b>	<b>62,668</b>	<b>60,745</b>	<b>79,778</b>	<b>75,863</b>	<b>73,080</b>	<b>80,210</b>	<b>80,612</b>	<b>112,137</b>	<b>114,831</b>

<b>GHGI Source</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
Compressors	285	1,716	0	0	0	3	3	0	0	0
Compressor Blowdowns	15,753	456	321	902	726	1,068	135	0	0	0
Compressor Starts	3,293	2,211	2,124	2,814	2,231	1,653	1,584	1,574	1,436	1,839
Dehydrator Vents/Kimray Pumps	53,649	57,670	22,964	23,382	18,898	18,039	14,607	15,881	10,904	7,104
Engines	27,752	27,225	26,710	25,911	26,651	25,400	19,447	31,724	17,493	13,338
Equipment Leaks	50,043	48,831	13,190	12,261	5,101	4,048	6,476	2,699	23	84
Produced Water	395	395	395	395	395	395	337	0	0	0
<b>Total</b>	<b>151,169</b>	<b>138,505</b>	<b>65,704</b>	<b>65,665</b>	<b>54,003</b>	<b>50,607</b>	<b>42,589</b>	<b>51,879</b>	<b>29,857</b>	<b>22,365</b>

**B-2. Annual Transmission and Storage Segment Gas STAR Reductions, by GHGI Emission Source, for 1990-2019 (mt CH<sub>4</sub>).**

<b>GHGI Source</b>	<b>1990</b>	<b>1991</b>	<b>1992</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>
Dehydrator Vents	0	0	0	61	74	77	849	3,374	3,371	3,341
Engines	0	0	0	2,803	6,007	9,108	11,438	13,495	35,790	37,132
Pipeline Leaks	0	0	0	136	0	33	465	0	21,251	3,382
Station Venting	0	0	0	1,071	429	1,164	1,650	916	1,239	1,113
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>4,071</b>	<b>6,510</b>	<b>10,381</b>	<b>14,402</b>	<b>17,784</b>	<b>61,652</b>	<b>44,969</b>

<b>GHGI Source</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
Dehydrator Vents	2,728	2,924	2,875	2,827	2,738	2,644	2,326	78	40	40
Engines	38,732	44,477	56,309	57,719	65,854	70,272	73,288	80,069	84,468	91,666
Pipeline Leaks	0	0	0	0	0	2	0	6,929	3,659	4,098
Station Venting	2,246	3,766	2,590	6,563	5,069	2,032	9,255	1,664	6,140	3,350
<b>Total</b>	<b>43,706</b>	<b>51,167</b>	<b>61,775</b>	<b>67,109</b>	<b>73,660</b>	<b>74,950</b>	<b>84,869</b>	<b>88,740</b>	<b>94,308</b>	<b>99,155</b>

<b>GHGI Source</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
Dehydrator Vents	40	40	40	40	40	40	0	0	0	1,330
Engines	80,186	80,959	69,933	68,924	69,284	68,328	65,603	62,697	63,420	80,067
Pipeline Leaks	5,066	6,972	6,972	1,919	4,179	1,194	2,534	4,085	4,083	590
Station Venting	3,475	2,541	3,152	3,393	2,589	2,983	17,042	24,760	26,796	19,312
<b>Total</b>	<b>88,768</b>	<b>90,512</b>	<b>80,098</b>	<b>74,277</b>	<b>76,093</b>	<b>72,545</b>	<b>85,179</b>	<b>91,542</b>	<b>94,299</b>	<b>101,299</b>

**B-3. Annual Distribution Segment Gas STAR Reductions, by GHGI Emission Source, for 1990-2019 (mt CH<sub>4</sub>).**

<b>GHGI Source</b>	<b>1990</b>	<b>1991</b>	<b>1992</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>
Pressure Relief Valve Releases	0	0	0	0	0	0	0	0	193	0
Pipeline Blowdowns	0	0	0	963	1,813	1,258	1,555	4,270	1,468	1,550
Mishaps (Dig-ins)	0	0	0	0	0	13	18	39	38	61
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>963</b>	<b>1,813</b>	<b>1,272</b>	<b>1,573</b>	<b>4,308</b>	<b>1,699</b>	<b>1,611</b>

<b>GHGI Source</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
Pressure Relief Valve Releases	0	0	1,490	0	0	1	10	0	143	0
Pipeline Blowdowns	1,502	1,607	3,111	1,682	2,646	4,746	7,564	1,639	1,592	1,209
Mishaps (Dig-ins)	13	42	51	100	343	604	802	2,368	1,087	1,482
<b>Total</b>	<b>1,516</b>	<b>1,650</b>	<b>4,652</b>	<b>1,781</b>	<b>2,989</b>	<b>5,351</b>	<b>8,376</b>	<b>4,007</b>	<b>2,822</b>	<b>2,691</b>

<b>GHGI Source</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
Pressure Relief Valve Releases	0	0	0	0	0	0	0	0	0	0
Pipeline Blowdowns	1,578	758	545	728	428	839	579	880	1,347	748
Mishaps (Dig-ins)	1,580	5,428	1,402	1,878	2,027	1,913	1,959	928	791	828
<b>Total</b>	<b>3,158</b>	<b>6,186</b>	<b>1,947</b>	<b>2,606</b>	<b>2,456</b>	<b>2,752</b>	<b>2,538</b>	<b>1,809</b>	<b>2,139</b>	<b>1,576</b>