# Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2019: Updates for Natural Gas Customer Meter Emissions

This memorandum discusses the updates implemented in EPA's 2021 *U.S. Inventory of U.S. Greenhouse Gas Emissions and Sinks* (GHGI) for industrial and commercial meters. Additional considerations for customer meters were previously discussed in a memorandum released in September 2020 (*Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2019: Updates Under Consideration for Natural Gas Customer Meter Emissions*).[1]

## 1 2020 (Previous) GHGI Methodology

EPA most recently updated the GHGI emissions calculation methodology for industrial and commercial meters in the 2016 GHGI by incorporating findings from a Gas Technology Institute (GTI) 2009 study[2] to estimate emissions. EPA's April 2016 memo *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2014: Revisions to Natural Gas Distribution Emissions*[3] documents the historical considerations and the full methodology used for industrial and commercial meters in the current GHGI.

In the 2020 (previous) GHGI, EPA estimated industrial and commercial meter emissions using Energy Information Administration (EIA) meter counts in each year paired with the GTI 2009 study commercial meter emission factor (EF) of 9.7 kg/meter/yr for both commercial and industrial meter types.[4] EPA applied the commercial meter EF to both commercial and industrial meters due to the limitations of available industrial meters data for revising EFs and based on stakeholder feedback.

## 2 Available Data

Two available data sources, 2009 and 2019 studies from GTI, include emissions data for industrial and commercial meters.

The emission factors in the 2020 GHGI came from a 2009 report by GTI and Innovative Environmental Solutions for Operations Technology Development (OTD) that investigated methane emission factors for select distribution sources (GTI 2009).[2] The emission sources included both metering and regulating (M&R) stations and customer meters. The GTI 2009 study conducted sampling of customer meters using screening and Hi-Flow Samplers to quantify total emissions from leaks and vents. The GTI 2009 study sampled 836 commercial meters at six companies and 46 industrial meters at five companies in five geographical regions across the United States. The study included both leak and vented emissions. An average EF was determined for each

[1] Stakeholder materials including draft and final memoranda for the current 1990-2019 Inventory and previous Inventories are available at https://www.epa.gov/ghgemissions/natural-gas-and-petroleum-systems.

[2] Gas Technology Institute and Innovative Environmental Solutions, *Field Measurement Program to Improve Uncertainties for Key Greenhouse Gas Emission Factors for Distribution Sources*, November 2009. GTI Project Number 20497. OTD Project Number 7.7.b.

[3] Available at <https://www.epa.gov/sites/production/files/2016-08/documents/final_revision_ng_distribution_emissions_2016-04-14.pdf>

[4] EIA defines the industrial sector as, "An energy-consuming sector that consists of all facilities and equipment used for producing, processing, or assembling goods… Overall energy use in this sector is largely for process heat and cooling and powering machinery, with lesser amounts used for facility heating, air conditioning, and lighting. Fossil fuels are also used as raw material inputs to manufactured products. This sector includes generators that produce electricity and/or useful thermal output primarily to support the above-mentioned industrial activities." EIA considers the commercial sector to include "service-providing facilities and equipment of businesses; Federal, State, and local governments; and other private and public organizations, such as religious, social, or fraternal groups. The commercial sector includes institutional living quarters. It also includes sewage treatment facilities. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a wide variety of other equipment. Note: This sector includes generators that produce electricity and/or useful thermal output primarily to support the activities of the above-mentioned commercial establishments." https://www.eia.gov/tools/glossary/index.php?id=I

company and an overall average EF was then calculated based on the number of meters tested for each company.

The 2019 GTI study[5] conducted sampling of customer meter sets using a combustible gas indicator (CGI) to screen for leaks and Hi-Flow Samplers to measure leak rates. Meter sets are defined as "the meter plus all components associated with that meter up to the point of transfer of hardware responsibility to the [gas] customer." This would include valves, flanges, tees, and other additional components associated with a meter. All components at a meter set were first scanned with the CGI to locate all leak indications with a concentration of at least 100 ppm. Depending on the campaign, leaks were then determined to be quantifiable when above either 22,500 ppm or 100 ppm. To quantify leak rates at the lower concentration threshold of 100 ppm, an ultraportable greenhouse gas analyzer (UGGA) was incorporated into the Hi-Flow Sampler to increase its measurement sensitivity. For eight of the thirteen campaigns, only leaks with indications above 22,500 ppm were quantified. For the remaining five campaigns, leaks above 100 ppm were quantified. Leaks that did not meet the concentration threshold of the campaign were not measured and quantified. Meters with a quantifiable leak were then measured using Hi-Flow Samplers. Unlike the 2009 study, the 2019 study only screened for leak emissions; vented emissions from regulators, pneumatic devices, or other sources were not included unless they were malfunctioning. An example of a malfunction included in the 2019 study would be a valve stuck in a position different from the intended vent position. The study sampled 186 meters at industrial locations and 337 meters at commercial sites in six geographic regions across the United States. An average EF was determined for each region as well as for the total population of commercial or industrial meters. The 2019 study also estimated leaker-only EFs and EFs specific to each meter type (rotary, diaphragm, etc.). Appendix B provides an overview of both the 2009 and 2019 study designs.

The GTI 2019 commercial meter EF (leaks only) is six times higher than the GTI 2009 study (which included both leaks and venting emissions). The 2009 value was quantified from a survey of 836 commercial meters, while the 2019 study surveyed 337 meters. GTI 2009 quantified an EF for industrial meters leaks and venting emissions that is higher than what was quantified by GTI 2019 for only leak emissions. The 2009 study surveyed 46 industrial meters, while the 2019 study surveyed 186. The small sample size of the GTI 2009 study and the wide variation observed among industrial meters led EPA to use the commercial EF for both commercial and industrial meter emissions estimates in 2016.

# 3 Analysis of Available Data

This section summarizes EPA's analyses of the recently published GTI 2019 study and considerations toward using data from either or both the 2009 and 2019 GTI studies to update the customer meters methodology in the 2021 GHGI. The commercial and industrial meter leak EFs presented in Section 3.2 were incorporated into the final 2021 GHGI methodology.

## 3.1 GTI 2019 Study

GTI 2019 presented multiple approaches for calculation of national emissions for potential use in the GHGI. Each approach is discussed in the following sections.

### 3.1.1 Population Emission Factors

GTI 2019 measured emissions rates at commercial and industrial meters in six regions across the country and calculated population EFs from the complete population of data. Meters that did not have a quantifiable leak, at the threshold used for each measurement campaign, were considered to have zero emissions in the

[5] Gas Technology Institute and US Department of Energy, *Classification of Methane Emissions from Industrial Meters, Vintage vs Modern Plastic Pipe, and Plastic-lined Steel and Cast-Iron Pipe.* June 2019. GTI Project Number 22070. DOE project Number ED-FE0029061.

population EF calculation. GTI found that adding the non-quantified leaks (e.g., leaks with a concentration less than 22,500 ppm but the particular measurement campaign was only quantifying leaks greater than 22,500 ppm) had a negligible impact on the mean population emission rate. Of the meter sets sampled, 82 percent of commercial meters and 87 percent of industrial meters were found to be leaking. Of those meter sets with leaks, 53 percent of commercial meters with leaks and 49 percent of industrial meters with leaks had quantifiable leaks. In the 2019 study, GTI recommends EPA use separate EFs for commercial and industrial meters. Table 1 presents the study's population EFs and sampling data.

**Table 1. GTI 2019 Commercial and Industrial Meter Population $CH_4$ EFs and Sampling Data**

| Parameter | Commercial Meters | Industrial Meters |
|---|---|---|
| EF (kg/meter/yr) | 57.4 | 117.8 |
| # Meter Sets Sampled | 337 | 186 |
| # Meter Sets with Leak Indication | 278 | 161 |
| # Meter Sets with Quantifiable Leak | 146 | 79 |

### 3.1.2 Regional Emission Factors

GTI 2019 conducted regional sampling of both commercial and industrial meters and found regional variation in EFs for both. Table 2 below shows the number of meter sets sampled and calculated EFs for each region. GTI recommends that EPA use regional EFs separated by commercial and industrial meter types. GTI stated that regional variation in EFs is in part due to differences in the main meter set type commonly used in a region. For example, in the Southeast region 75 percent of meters measured were turbine meters (which GTI found to have the highest emissions). Additionally, GTI noted it is possible that differences in leak identification and repair procedures in each region explain the variation. Their analysis found that the regions with the highest EFs also had the highest likelihood of finding a large leak.

**Table 2. GTI 2019 Commercial and Industrial Meter Regional CH4 EFs (kg/meter/yr) and Sampling Data**

| Region | Commercial Meter Sets Sampled | Commercial Meter EF | Industrial Meter Sets Sampled | Industrial Meter EF |
|---|---|---|---|---|
| Midwest | 99 | 28.4 | 77 | 52.3 |
| Northeast | 75 | 20 | 13 | 172.5 |
| Pacific | 63 | 4 | 52 | 17.4 |
| Rocky Mountain | 12 | 108.4 | 9 | 322.5 |
| Southeast | 5 | 139.3 | 15 | 291.7 |
| Southwest | 83 | 153.9 | 20 | 372.9 |
| All | 337 | 57.4 | 186 | 117.8 |

### 3.1.3 Leaker Emission Factors

In the 2019 study, GTI found that 43% of the meter sets sampled had a quantifiable leak. GTI's analysis found that the Pacific region had the highest likelihood of having no leaks or small leaks, and that the Rocky Mountain, Southeast, and Southwest regions had the highest likelihood of finding substantial leaks. Table 3 shows the leaker EFs by region.

**Table 3. GTI 2019 Commercial and Industrial Meter Regional Leaker $CH_4$ EFs (kg/meter/yr) and Sampling Data**

| Region | Commercial Meter Sets with Quantifiable Leak | Commercial Meter Leaker EF | Industrial Meter Sets with Quantifiable Leak | Industrial Meter Leaker EF |
|---|---|---|---|---|
| Midwest | 58 | 48.5 | 35 | 260.0 |
| Northeast | 20 | 75.1 | 6 | 564.9 |
| Pacific | 28 | 9.0 | 9 | 233.3 |
| Rocky Mountain | 4 | 325.3 | 5 | 745.9 |
| Southeast | 4 | 174.1 | 15 | 707.1 |
| Southwest | 32 | 399.1 | 9 | 1045.8 |
| All | 146 | 132.4 | 79 | 277.4 |

## 3.2 Combined GTI 2009 and GTI 2019 Dataset

In addition to considering options that use the 2019 GTI dataset alone to update the GHGI, EPA also considered options that combined the results from both the 2009 and 2019 studies to develop weighted average population EFs. EPA used the number of samples in the respective studies to weight the EFs.

When considering both datasets, EPA evaluated leak versus vented emissions; the GTI 2009 study measured leak and vented emissions and the GTI 2019 study focused on leak emissions only. The inclusion of vented emissions leads to significantly higher industrial meter EFs in the GTI 2009 study compared with the 2019 study. The GTI 2009 study did not report leak and vented emissions separately for commercial meters. As the GTI 2009 commercial meter EF is lower than the GTI 2019 EF, vented emissions may not have a noticeable impact for commercial meters. Table 4 presents the commercial meter weighted average $CH_4$ EF.

**Table 4. Commercial Meter Weighted Average Population $CH_4$ EF (kg/meter/yr)**

| Study | Data Points | Commercial Meter $CH_4$ EF |
|---|---|---|
| GTI 2009 | 836 | 9.73 |
| GTI 2019 | 337 | 57.4 |
| **Weighted Average EF** | | **23** |

As noted previously, industrial meter EFs from the GTI 2009 study were not incorporated in the 2016 GHGI customer meters updates, due to the limited sample size. EPA re-evaluated these data for the current analyses. Industrial meter emissions from "Company B" in the GTI 2009 data account for 95% of the total industrial meter emissions of the dataset. The 2009 GTI study noted that the meter emissions measured for Company B are largely due to pneumatic controller vented emissions. GTI 2009 also noted that the meter type of Company B was similar to a metering and regulating station, versus a traditional meter (e.g., turbine, rotary).

EPA discussed vented versus leak emissions with the GTI 2019 study authors, and the authors noted that for the 2019 study data set (1) pneumatic controllers were not observed to be venting during the measurement campaigns and (2) some regulators were observed to be venting during the measurement campaigns but their emissions were variable and not quantified.

Table 5 presents the GTI 2009 industrial meters data, including the breakdown between leak and vented emissions. Table 6 presents the resulting industrial meter weighted average $CH_4$ EFs for the 2009 and 2019 GTI studies, including separate weighted average EFs for leak and vented emissions. The vented emissions EF

presented in Table 6 incorporates the default assumption that vented emissions were zero during all GTI 2019 study measurements (i.e., it uses the data as-reported in each study). EPA considered whether that is a reasonable assumption, or if vented emissions data should be calculated only from the GTI 2009 study data or with some other approach.

**Table 5. GTI 2009 Industrial Meters Data**

| Company | # Industrial Meters Sampled | Leak $CH_4$ Emissions (kg/yr) | Vented $CH_4$ Emissions (kg/yr) | $CH_4$ Emissions (kg/yr) |
|---|---|---|---|---|
| A | 7 | 411 | 0 | 411 |
| B | 7 | 734 | 170,341 | 171,075 |
| C | 0 | 0 | 0 | 0 |
| D | 2 | 29 | 6,616 | 6,646 |
| E | 22 | 609 | 9 | 618 |
| F | 8 | 735 | 0 | 735 |
| **Total** | **46** | **2,519** | **176,965** | **179,485** |
| **EF (kg/meter/yr)** | | **55** | **3,847** | **3,902** |

**Table 6. Industrial Meter Weighted Average Population $CH_4$ EFs (kg/meter/yr)**

| Study | Data Points | Leak Emissions $CH_4$ EF | Vented Emissions $CH_4$ EF | Total $CH_4$ EF |
|---|---|---|---|---|
| GTI 2009 | 46 | 55 | 3,847 | 3,902 |
| GTI 2019 | 186 | 117.8 | N/A | 117.8 |
| **Weighted Average** | | **105** | **763** | **868** |

# 4 Regional Variability and Time Series Considerations

The update for the 2021 GHGI does not include changes to the activity data. EPA applied the commercial and industrial meter EFs across the time series, along with EIA activity data for commercial and industrial meters. This is consistent with the approach for residential meters. If stakeholder information indicating that emission rates from commercial and industrial meters have changed over the time series, and data were available to do so, EPA would consider using different EFs over time.

GTI 2019 recommends using region-specific EFs based on their findings of different meter set types in different regions. The EIA dataset that EPA uses for industrial and commercial meter counts includes counts by state,[6] and EPA could apply region-specific EFs to the meter counts from states within each region. Due to the limited measurement data for each region, EPA applied national EFs in the 2021 GHGI and did not use regional EFs.

# 5 Updated EFs and National Emissions Estimates for Customer Meters in the 2021 GHGI

Based on the data sources and considerations discussed in Sections 3 and 4, this section summarizes the approach EPA implemented in the 2021 GHGI.

EPA applied a weighted average EF for each meter type to the activity data for that meter type.

[6] http://www.eia.gov/dnav/ng/ng_cons_num_a_epg0_vn5_count_a.htm

For commercial meters, EPA applied the weighted average EF in Table 4, which is based on data from both the GTI 2009 and 2019 studies.

For industrial meters, EPA applied the weighted average leak EF from Table 6, which is based on leak emissions from both the GTI 2009 and 2019 studies. EPA did not incorporate vented emissions, due to significant variability in the limited available data.

EIA provides activity data in the form of meter counts divided into industrial and commercial meters. In the current GHGI, these values are summed. For the 2021 GHGI update, EPA used unique counts for industrial and commercial meters and applied the respective EFs.

Table 7 compares the results for the commercial and industrial meters 2021 GHGI update for year 2018 to the previous 2019 GHGI results. Appendix A provides time series data for each meter type.

Note that the current 2018 values in the 2020 GHGI were based on an incorrect national industrial meter count due to a spreadsheet error. Both the 2018 value reported in the 2020 GHGI and the corrected value for the 2021 GHGI are included in the table below. The spreadsheet error only impacted year 2018 emissions.

**Table 7. Year 2018 Customer Meters National Emissions Estimates Calculated by the Updated Approaches**

| Meter Type | EF Basis | EF (Kg/meter/year) | AD (# meters) | 2018 Emissions (MT $CH_4$) |
|---|---|---|---|---|
| **Commercial Meters** | | | | |
| 2021 GHGI | Weighted - GTI 2009 and 2019 | 23.43 | 5,515,358 | 129,130 |
| *2020 GHGI* | *GTI 2009 (commercial EF)* | *9.7* | *5,515,841* | *53,692* |
| **Industrial Meters** | | | | |
| 2021 GHGI | Weighted - GTI 2009 and 2019 | 105 | 185,008 | 19,426 |
| *2020 GHGI* | *GTI 2009 (commercial EF)* | *9.7* | *251,484* | *2,448* |
| *2020 GHGI - CORRECTED* | *GTI 2009 (commercial EF)* | *9.7* | *185,008* | *1,801* |

# 6 Requests for Stakeholder Feedback

EPA sought stakeholder feedback on the approaches under consideration through two 2020 webinars, in the September 2020 memo, and in the public review draft of the GHGI. EPA received comments on the September 2020 version of the *Customer Meters* Memo and through the public review draft of the Inventory. These comments included a recommendation to delay updates until additional data could be collected. The comments also recommended using separate EFs for commercial and industrial meters and region-specific EFs. The largest source of emissions from customer meters in the 2009 study was vented emissions from industrial meters, with an average emission factor per meter of 3,487 kg/year, compared with an average emission factor per industrial meter from leaks of 105 kg/year. Venting emissions were observed and measured at 2 out of the 6 companies participating in the 2009 GTI study. This source of emissions was not studied in the 2019 GTI study. The final methodology for industrial meters uses an EF calculated only from leak emissions, which have less variability, and does not include the more limited and highly variable vented emissions. EPA did not use region-specific EFs due to the limited data available for each region, but did finalize separate EFs for commercial and industrial meters that rely on the leak emissions from the 2009 and 2019 GTI studies. Using data from both studies to calculate population EFs greatly increases the number of data points that serve as the basis of the EFs, instead of only using the commercial meter EF from the 2009 GTI study. EPA seeks

stakeholder feedback on upcoming or ongoing research studies that measure vented emissions from industrial meters.

The questions below were not updated for this memorandum and are copied from the September 2020 memo.

1. EPA seeks feedback on how to incorporate industrial meter venting emissions. The GTI 2019 study did not measure venting emissions, but regulator venting emissions were observed (though variable in nature). Table 6 presents weighted average EFs calculated from all study data, and which therefore has a default assumption incorporated that venting emissions were zero during all GTI 2019 study measurements. While regulator venting emissions were observed, the study does not have an indication as to the magnitude of their impact.
2. EPA seeks feedback on how to incorporate industrial meter leak emissions, including whether using solely the GTI 2019 EF, or a weighted average EF (calculated from the combined dataset) is most appropriate.
3. EPA seeks feedback on how to incorporate leak and venting emissions for commercial meters, including whether using the GTI 2019 EF or a weighted average EF (calculated from the combined dataset) is most appropriate. EPA also seeks feedback on whether commercial meter vented emissions should be supplemented with vented emissions data from industrial meters or if other data are available to address vented emissions from commercial meters. Detailed leak and vented emission are not available in the GTI 2009 study to determine the percent that each contributes. In addition, the GTI 2019 study EF (which only reflects leak emissions) is higher than the GTI 2009 EF (which includes leak and vented emissions), which could suggest that vented emissions may not be a significant contributor to commercial meter emissions.
4. In addition to the specific leak and vented emissions questions above, EPA generally seeks feedback on the most appropriate EFs to apply for commercial and industrial meters. This includes whether GTI 2019 study EFs should be applied, if weighted average EFs based on the GTI 2009 and 2019 studies are more appropriate, if regional EFs should be considered, or if another approach or data source is recommended.
5. EPA seeks feedback on whether different EFs should be applied over the time series. EPA is considering applying the same EFs, but could consider applying one EF to early years of the time series and a different EF to recent years, with linear interpolation between if there is information available indicating that the emission rate per meter has changed over the time series.

# Appendix A – Comparison of 2021 GHGI Update and 2020 GHGI Time Series Emissions and Activity Data for Commercial and Industrial Meters

### Commercial and Industrial Meter $CH_4$ Emissions (MT $CH_4$/Year)

| Meter Type | EF Basis | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Commercial Meters** | | | | | | | | | | | | | | | | |
| **2021 GHGI** | Weighted-GTI 2009 and 2019 | 99,129 | 101,960 | 103,187 | 104,479 | 106,093 | 108,494 | 110,453 | 111,417 | 118,041 | 117,238 | 117,253 | 116,917 | 118,507 | 120,561 | 120,275 |
| **2020 GHGI** | GTI 2009 (commercial EF) | 41,236 | 42,414 | 42,924 | 43,462 | 44,133 | 45,132 | 45,947 | 46,348 | 49,104 | 48,770 | 48,776 | 48,636 | 49,297 | 50,152 | 50,033 |
| **Industrial Meters** | | | | | | | | | | | | | | | | |
| **2021 GHGI** | Weighted – GTI 2009 and 2019 | 22,296 | 22,736 | 22,010 | 22,015 | 21,309 | 21,987 | 21,635 | 24,660 | 23,750 | 23,975 | 23,126 | 22,788 | 21,621 | 21,579 | 21,951 |
| **2020 GHGI** | GTI 2009 (commercial EF) | 2,125 | 2,108 | 2,040 | 2,041 | 1,975 | 2,038 | 2,006 | 2,286 | 2,202 | 2,223 | 2,144 | 2,113 | 2,004 | 2,000 | 2,035 |

| Meter Type | EF Basis | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Commercial Meters** | | | | | | | | | | | | | | | | |
| **2021 GHGI** | Weighted-GTI 2009 and 2019 | 121,634 | 123,397 | 124,226 | 127,397 | 124,543 | 124,057 | 124,484 | 125,340 | 125,717 | 126,677 | 127,615 | 128,108 | 128,698 | 129,130 | 129,796 |
| **2020 GHGI** | GTI 2009 (commercial EF) | 50,598 | 51,332 | 51,676 | 52,996 | 51,808 | 51,606 | 51,784 | 52,140 | 52,297 | 52,696 | 53,086 | 53,291 | 53,524 | 53,692 | n/a |
| **Industrial Meters** | | | | | | | | | | | | | | | | |
| **2021 GHGI** | Weighted- GTI 2009 and 2019 | 21,653 | 20,352 | 20,820 | 23,630 | 21,801 | 20,237 | 19,877 | 19,884 | 20,190 | 20,175 | 19,775 | 19,828 | 19,419 | 19,426 | 19,239 |
| **2020 GHGI** | GTI 2009 (commercial EF | 2,007 | 1,887 | 1,930 | 2,191 | 2,021 | 1,876 | 1,843 | 1,843 | 1,872 | 1,870 | 1,833 | 1,838 | 1,800 | 1,801[a] | n/a |

a – Corrected value for 2018 industrial meters emissions. The current 2018 values in the 2020 GHGI were based on an incorrect national industrial meter count due to a spreadsheet error. The spreadsheet error only impacted year 2018 emissions. The 2018 value for $CH_4$ from industrial meters presented in the 2020 GHGI was 2,448 kt $CH_4$. Please see section 5 of this memo for additional information.

### Activity Data: Number of Commercial and Industrial Meters in 2021 GHGI

| Meter Type | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Commercial** | 4,236,280 | 4,357,252 | 4,409,699 | 4,464,906 | 4,533,905 | 4,636,500 | 4,720,227 | 5,064,384 | 5,152,177 | 5,139,949 | 4,236,280 | 4,357,252 | 4,409,699 | 4,464,906 | 4,533,905 |
| **Industrial** | 218,341 | 216,529 | 209,616 | 209,666 | 202,940 | 209,398 | 206,049 | 205,915 | 205,514 | 209,058 | 218,341 | 216,529 | 209,616 | 209,666 | 202,940 |

| Meter Type | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018[a] | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Commercial** | 5,198,028 | 5,273,379 | 5,308,785 | 5,444,335 | 5,322,332 | 5,301,576 | 5,319,817 | 5,356,397 | 5,372,522 | 5,413,546 | 5,453,627 | 5,474,701 | 5,499,934 | 5,515,358 | 5,546,847 |
| **Industrial** | 206,223 | 193,830 | 198,289 | 225,044 | 207,624 | 192,730 | 189,301 | 189,372 | 192,288 | 192,139 | 188,336 | 188,836 | 184,947 | 185,008 | 183,233 |

# Appendix B – Study Design Information

| Meter Type | Measurement Type | Number of Sources | Location and Representativeness | EF Calculation Method |
|---|---|---|---|---|
| **GTI 2009** | | | | |
| Commercial | Hi Flow Sampler measurements of leaks and vents | 836 meters at 6 companies | Spread across five areas of the U.S. Randomly selected meters. The meters tested equal approximately 0.11% of the meters in operation at the 6 companies | GTI developed a weighted average EF based on number of meters tested. |
| Industrial | Hi Flow Sampler measurements of leaks and vents | 46 meters at 5 companies | Spread across five areas of the U.S. Meters were randomly selected. | GTI developed a weighted average EF based on number of meters tested |
| **GTI 2019** | | | | |
| Commercial | Hi Flow Sampler measurements of leaks | 337 meters at 10 companies | Spread across six regions of the U.S. Initial site for the day was randomly selected, efficient route determined from there. | GTI developed EFs in multiple ways: population, leaker-only, regional |
| Industrial | Hi Flow Sampler measurements of leaks | 186 meters at 10 companies | Spread across six regions of the U.S. Meters were randomly selected | GTI developed EFs in multiple ways: population, leaker-only, regional |