# Reconciling Top-down and Bottom-up Methane Emissions Estimates in the Delaware Basin

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# Supplementary Materials

Table S1 - 2020 bottom-up emission estimate for the Delaware basin, TX, calculated using Tier 1 emission factors

Table S2 - Data source of 2020 GHGRP emission factors

# Supplementary Material Section 1 2020 bottom-up emission estimate for the Delaware basin, TX, calculated using Tier 1 emission factors

*Table S1 Tier 1 - Fugitive Emissions from Oil and Natural Gas Systems in developed countries (IPCC, 2023, 2006, 2014). EF-symbolizes “Emission Factor”. Emission units are: 1. kg CH4 per 103 m3 oil; 2. kg CH4 per 106 m3 gas; or 3. kg CH4 per 106 m3 condensate. Category Source: Fl – Flaring, Fu – Fugitive and V - Venting*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Category | Min EF | Max EF | ±U (%) | EF Unit | Gas Loss (Gg y-1) | | | |
|  |  |  |  |  | Min | Best | Max |
| Gas Production (Fu) | 380 | 2300 | 100 | 2 | 0.0 | 140 | 482 |
| Gas Production (Fl) | 0.76 | 0.76 | 25 | 2 | 0.06 | 0.08 | 0.10 |
| Oil Production (Fu) | 1.5 | 3600 | 100 | 1 | 0.0 | 242 | 968 |
| Oil Production (V) | 720 | 720 | 50 | 1 | 48 | 97 | 145 |
| Oil Production (Fl) | 25 | 25 | 50 | 1 | 1.7 | 3.4 | 5.0 |
| Servicing (Fl/V) | 110 | 110 | 50 | 1 | 7.4 | 15 | 22 |
| Gas Transmission (Fu) | 66 | 180 | 100 | 2 | 0.0 | 13 | 38 |
| Gas Transmission (V) | 44 | 320 | 75 | 2 | 8.4 | 19 | 59 |
| Condensate Transport (Fu) | 110 | 110 | 100 | 3 | 0.0 | 15 | 30 |
| Oil Transport (Fu) | 5.4 | 5.4 | 100 | 1 | 0.0 | 0.73 | 1.5 |
| Gas Processing (Fu) | 150 | 1030 | 100 | 2 | 0.0 | 62 | 215 |
| Gas Processing (Fl) | 2 | 2 | 25 | 2 | 0.16 | 0.21 | 0.26 |
| Total |  |  |  |  | 66 | 607 | 1,966 |

Sources: Canadian Association of Petroleum Producers (1999, 2004); API (2004); GRI/US EPA (1996); US EPA (1999).

# Supplementary Material Section 2 Data source of 2020 emission factors

*Table S4 Data source of 2020 emission factors*

|  |  |
| --- | --- |
| Source | Data source (EPA GHGRP) |
| Large/Small Tanks | 2015-2020: Calculated using basin-specific and year-specific GHGRP subpart W data for each tank category (EPA, 2022). |
| Malfunctioning Separator Dump Valves | 2015-2020: Calculated using basin-specific and year-specific GHGRP subpart W data for each tank category (EPA, 2022). |
| Pneumatics | 2011-2021: calculated using basin-specific and year-specific GHGRP subpart W data for each bleed type (EPA, 2022). |
| Chemical Injection Pumps | RY2014 subpart W (EPA, 2016a) |
| Vessel Blowdowns | GRI/EPA (1996) |
| Compressor Blowdowns | GRI/EPA (1996) |
| Compressor Starts | GRI/EPA (1996) |
| Associated Gas Venting | Basin-specific (reported subpart W) (EPA, 2022) |
| Produced Water | EPA's Oil & Gas Tool for 2017 NEI (EPA, 2017b; EPA, 2021b) |
| Oil Wellheads | 1996 API workbook (API, 1996) |
| Separators | 1996 API workbook (API, 1996) |
| Heater/Treaters | 1996 API workbook (API, 1996) |
| Headers | 1996 API workbook (API, 1996) |
| Compressors | Consensus of Industry Review Panel |
| Sales Areas | Consensus of Industry Review Panel |
| Pipelines | Assumed to be zero due to lack of data |
| Battery Pumps | API (1995) |
| Gas Engines | GRI/EPA (1996) |
| Heaters | EPA (1997) |
| Associated Gas Flaring | Basin-specific (reported subpart W) (EPA, 2022). |
| Miscellaneous Production Flaring | Basin-specific (reported subpart W) (EPA, 2022). |
| Pressure Relief Valves | GRI/EPA (1996) |
| Well Blowouts Onshore | Assumed 2.5 MMscf/blowout |