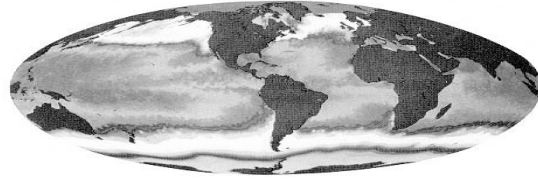


La Plata County Natural Gas Industry Greenhouse Gas Emissions Estimate, 2006

Report to The Brendle Group in Support of the La Plata County Inventory



By Richard Heede
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19 February 2008



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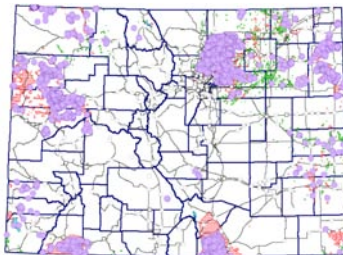
to La Plata Board of County Commissioners for their commitment to climate stewardship

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Report commissioned by The Brendle Group
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Note on units: Metric units are used throughout this report, except in cases of common US units, e.g., gas production in billion cubic feet (Bcf). One metric tonne = 1.1023 short tons. Methane is expressed in CO₂equivalent terms (CO₂e) at 21xCO₂.



www.cdphe.state.co.us/ap/down/O&G07AssessOct.pdf

Cover: Rules Hill & Vosburg Pike area northwest of Bayfield. Google satellite image.

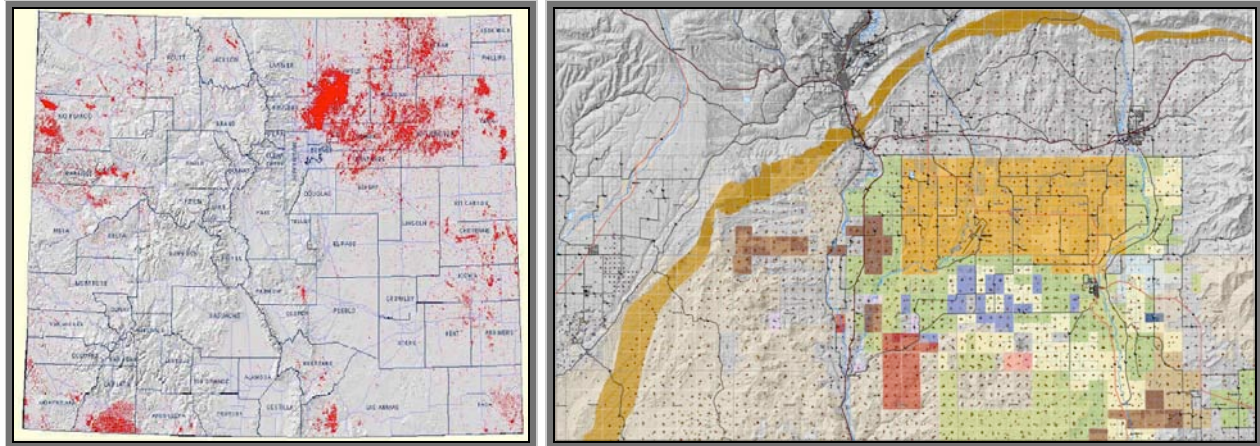
La Plata gas industry GHG emissions: methodology and results

Introduction

Gas industry operators in La Plata County produced 437 billion cubic feet (Bcf) of natural gas in 2006 from 2,886 operating wells. This equals 35 percent of Colorado’s natural gas production totaling 1,233 Bcf and 2.3 percent of US marketed production totaling 19,338 Bcf. La Plata production was chiefly from the shallower Fruitland Formation from which coal bed methane (CBM) is recovered. A minor quantity of crude oil (30,048 bbl) was also produced in La Plata County in 2006, although amounting to 0.13 percent of Colorado’s total oil production.

Climate Mitigation Services (CMS) was commissioned by The Brendle Group to estimate emissions of carbon dioxide and methane from the gas industry in La Plata county. The Brendle Group was awarded the contract with La Plata Community Development Dept to inventory all major direct and indirect sources of greenhouse gas emissions from energy consumption, energy production, land use, wastewater treatment plants, landfills, and other sources in or attributable to the county. These sources include consumption of transportation fuels (gasoline, diesel, and jet fuel), combustion of natural gas and propane for residential heating or industrial uses, and power plants supplying electricity to the homes, businesses, and industries operating within the county.

Fig. 1. Gas wells in Colorado (left) and in La Plata County (right)



Left: Colorado gas wells, CDPHE (2007), slide 5. Right: La Plata County gas wells, La Plata County GIS.

No estimates of gas industry greenhouse gas (GHG) emissions in La Plata County have been published to date, although criteria pollutants such as NO_x and ozone are monitored and reported. Neither the State of Colorado Oil and Gas Conservation Commission (COGCC) or the State’s Dept of Public Health & Environment’s Air Pollution Control Division requires reporting of methane and carbon dioxide, and neither agency has estimated GHG emissions from the state’s energy industries. Awareness of the issue of climate change has led to efforts to identify and quantify company, municipal, and individual and household GHG emissions. However, the results of any Plata County operator’s efforts to quantify emissions that may be underway are not yet publicly available.

Major gas industry GHG emissions sources

There are three principal categories of emissions sources pertinent to the natural gas industry.

1. Methane sources include routine operations, fugitive releases, field operations, pipelines, pneumatic device vents, gas-oil separation plants (GOSPs), Kimray pumps, dehydrator vents, centrifugal and reciprocal compressors, internal combustion engines, seals, flanges, meters, pipeline leaks, upsets, incomplete flaring, and so forth.
2. Carbon dioxide from industry use of natural gas, diesel fuel, electricity, and (in some cases) steam.
3. Carbon dioxide vented from produced natural gas. Natural gas, while chiefly methane, also contains entrained CO₂, sometimes in high concentrations, as is apparently the case in the San Juan Basin, and especially from coal bed methane such as the Fruitland Formation. The New Mexico section of the Fruitland Formation has a CO₂ content exceeding 17 percent. CMS has been unable to verify the concentration of entrained CO₂ in La Plata's produced gas.

Methodology

Estimating emissions from an industry as complex as natural gas production across several producing formations and dozens of operating companies in varying stages of production cannot be reliably estimated from the ground up without in-depth data from the industry. CMS inquired about company emissions estimates, but none have been published.

The Center for Climate Strategies (CCS) completed a statewide inventory of Colorado emissions sources in 2007, including the oil, gas, and coal mining industries. Although industry methane emissions were estimated using EPA's State Greenhouse Gas Inventory Tool (SGIT), neither carbon dioxide emissions from fuel combustion nor entrained CO₂ were estimated for Colorado. CCS did quantify gas industry CO₂ emission in its 2006 New Mexico state inventory.

Fig. 2. Map of the San Juan Basin gas-producing region of New Mexico and Colorado.



Source: La Plata County Energy Council, Inc., www.energycouncil.org/

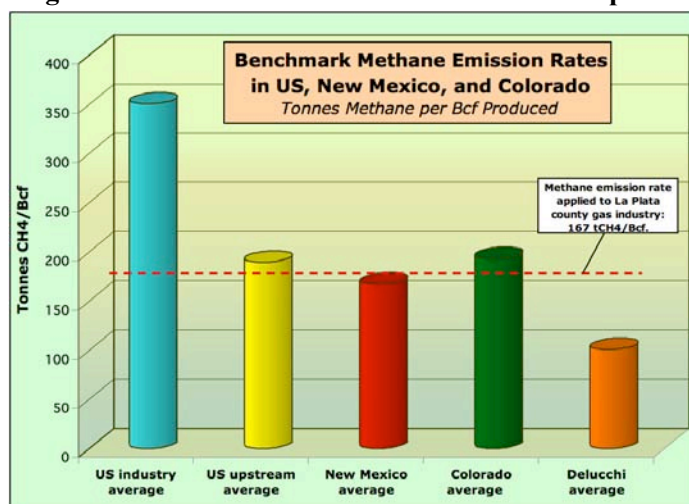
While not as accurate as industry-provided data that includes all relevant emissions sources, a commonly used estimation method in state, regional, and corporate inventories is to apply relevant emission *rates* per unit of gas produced. CMS calculated benchmark emissions rates of CO₂ and methane per Bcf of annual production for several pertinent producing regions. Emission rates were computed for New Mexico (especially the San Juan Basin shared with and underlying La Plata county; Fig. 2), the State of Colorado, and compared to a range of US domestic gas industry as analyzed by Kirchgessner, US EPA, Delucchi, CMS, and others.

CMS elected to use emission rates in New Mexico as the model for La Plata County gas industry emissions for three principal reasons: 1) it is based significantly on emissions rates for the San Juan Basin, 2) the emission rates were substantially based on industry-provided data, and 3) the NM inventory included all major sources of gas industry emissions sources — entrained CO₂, fuel combustion, and methane — that CMS wanted to include in the present La Plata inventory.

CMS analyzed the methods and results of the gas industry estimate for New Mexico that detailed useful data on emission rates for various stages of production, processing, transportation and storage, and distribution. This industry data complements and supports the results of the New Mexico gas industry emissions estimate in the Center for Climate Strategies (2006) *New Mexico Greenhouse Gas Inventory*.¹ Since La Plata and New Mexico produce gas from the shared San Juan Basin’s Fruitland and Dakota Formations, the emission rates in New Mexico can reasonably be assumed to be applicable to La Plata. Future research and the availability of gas industry data specific to La Plata can be expected to revise the present CMS gas industry emissions estimate, especially as material differences across the San Basin and operator practices come to light.

The New Mexico emission rate is 167 tonnes of methane per billion cubic feet of gas produced (tCH₄/Bcf). The CO₂ emission rate is 6,590 tCO₂/Bcf. The benchmark methane emission rates evaluated by CMS are shown in Fig. 3. The combined methane and carbon dioxide emission rate (at CH₄ GWP of 21xCO₂) of the “best” (median) estimate is 7,649 tCO₂e/Bcf, which equates to 13 percent of hypothetical full combustion of the produced natural gas (see Fig. 7).²

Fig. 3. Benchmark methane emission rates compared.



Recognizing that the gas industry in La Plata *may* emit carbon dioxide and methane at lower rates than New Mexico (see “Caveats and Uncertainties”), CMS reduces the combined emission rate by 24.3 percent and 48.6 percent for in the “best” and “low” estimates, respectively. CMS

¹ This industry data was used by CCS in developing the NM gas industry emissions estimates and there are no material differences between the two sources. See CCS (2006), Appendix D, Table D-13 for summary data. CMS bases its La Plata gas industry emissions in the CO₂ and methane emission rates developed for New Mexico.

² Hypothetical in that all produced gas is not marketed (some is used in the field, or flared), and does not account for incomplete combustion or non-fuel uses of natural gas. Even so, 13 percent is conservative: Spath & Mann (2000) found 24.9 percent (with a roughly similar boundary definition), Jaramillo et al (2007) suggest 13.6 percent adder for upstream emissions; Delucchi also considers the CMS rate reasonable (personal communication, 21Dec07) considering the high entrained CO₂ content of coal bed methane.

uses the New Mexico emission rates as the basis for the “high” emissions estimate in La Plata, and the “low” estimate is 51.4 percent of the “high” estimate.³ As a conservatism, CMS uses the average of the “high” and “low” estimates as the preferred estimate when reporting emissions of La Plata’s gas industry; in the results section this is referred to as the “best” estimate.

Caveats & uncertainties

The CMS gas industry estimate is certain to be revised when the gas industry responds with credible revisions to the CMS methodology with updated and documented emission rates or monitored emissions covering all relevant GHG sources. Indeed, the industry may release its own comprehensive inventory. The current inventory should be considered a first approximation, and CMS encourages the gas industry in La Plata to help improve the present methodology. It may be the case that gas operators in La Plata county have not yet estimated emissions—even in their own operations. If so, the collaborative interest from the State, the La Plata Board of County Commissioners, and citizens may facilitate fruitful discussions of ways to develop and share such data in due course.

Also, there may be mitigating factors not reflected in the present emissions inventory. The entrained CO₂ content of La Plata’s produced gas may be lower than in New Mexico’s section of the San Juan Basin, La Plata operators may re-inject the entrained CO₂ (if captured) to enhance oil recovery elsewhere in the county (or export the captured CO₂ to, say, Texas). Or less fuel may be used in field operations, pipelines, and processing plants in La Plata than the New Mexico model suggests. Or La Plata gas operators may be early adopters of many of the emissions reduction measures discussed in the Four Corners Air Quality Task Force report.

On the other hand, the reverse may also be true, and CMS may have under-estimated emissions in La Plata, especially since the emission rates applied to La Plata are ~24 percent lower than the New Mexico model suggests. Regardless, industry review of the present methodology will help improve future gas industry emissions — and may substantially alter the results.

CMS has *not* estimated emissions from the production of crude oil. La Plata’s crude oil production (30,048 bbl in 2006) is small compared to its natural gas production, and emissions from oil production are relatively low compared to natural gas.

Results

CMS calculated “low,” “best”, and “high” emissions for La Plata’s gas industry. Gas production in the county totaled 437 Bcf in 2006. Using the actual New Mexico emission rates as the “high” estimate, La Plata emissions total 4.42 million tonnes CO₂e per year (MtCO₂e/yr). The “low” estimate is 51.4 percent of the high estimate and totals 2.27 MtCO₂e/yr. CMS uses the median “best” estimate when reporting gas industry emissions to The Brendle Group. The median estimate is 75.7 percent of the high estimate and totals 3.34 MtCO₂e/yr. The three estimates are shown in Fig. 4, and the “best” estimate of emissions by type is shown in Figs. 5, 6, & Table 1. All computations, details, and cell notes are shown in the PDFs of worksheet in the Appendix.

³ The “low” estimate is based on the computed rate of U.S. domestic natural gas industry methane emissions plus CO₂ from venting and flaring. This CO₂ rate is known to be low, especially since La Plata’s gas production is 89 percent coal bed methane with much higher entrained CO₂. Also, the U.S. venting data is poorly documented (GAO, 2004) and likely underestimated. As a conservatism, CMS applies this rate as the La Plata “low.”

La Plata County gas industry GHG emissions estimate

Fig. 4. La Plata gas industry emissions: “low,” “best,” and “high” estimates.

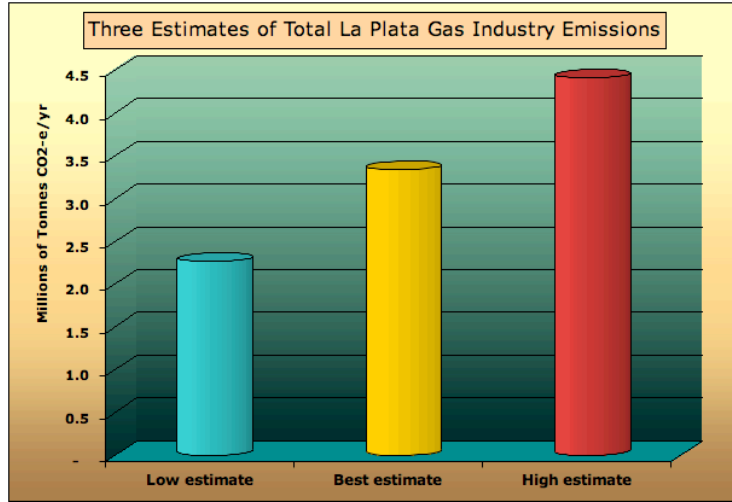


Fig. 5. La Plata gas industry “best estimate” GHG emissions

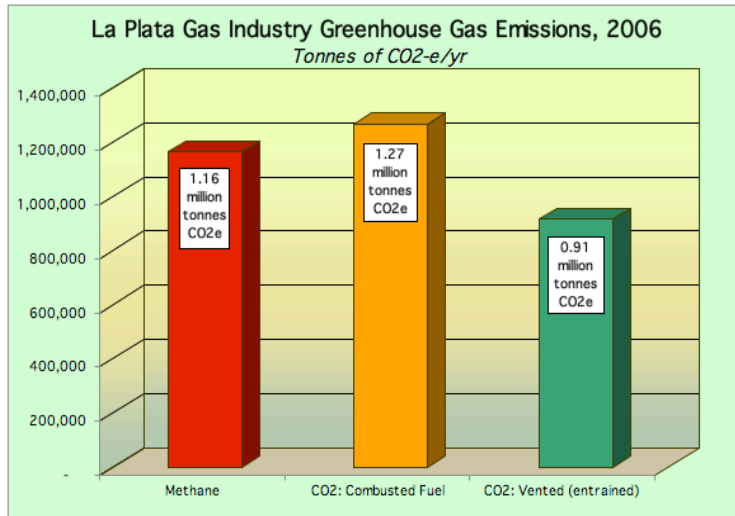


Fig. 6. Emissions by type, in percent

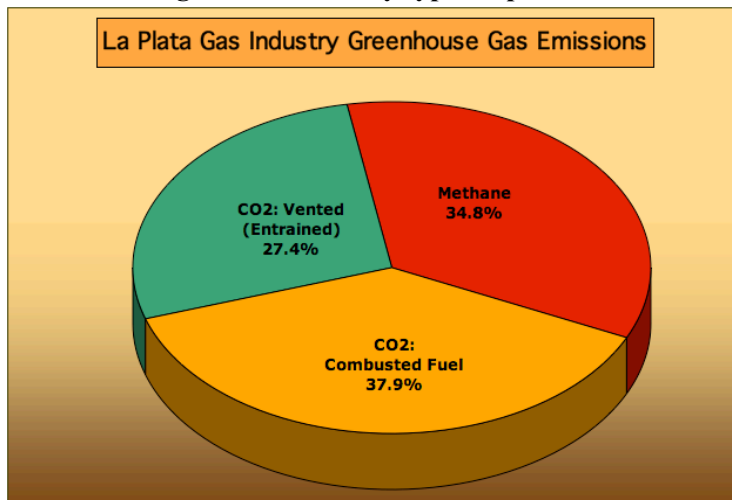


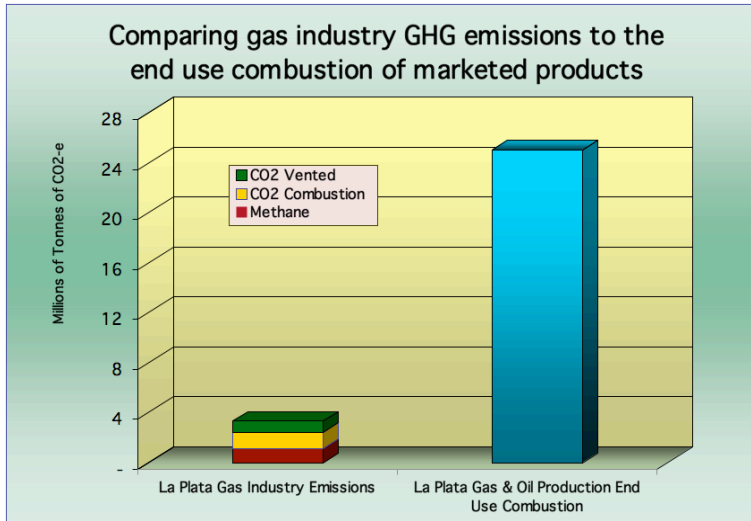
Table 1. La Plata gas industry GHG emissions “best estimate” 2006, in tonnes CO₂e

Industry segment	Carbon Dioxide	Methane	Total
Production	381,786	744,196	1,125,982
Processing	1,324,764	185,820	1,510,584
Transmission	474,036	172,507	646,543
Distribution	negl	60,652	60,652
Total	2,180,586	1,163,175	3,343,761

Emission source	Carbon Dioxide	Methane	Total
Combustion	1,265,835		1,265,835
Vented CO ₂	914,751		914,751
Methane		1,163,175	1,163,175
Total			3,343,761

CMS estimates that complete combustion of the gas produced and marketed in La Plata County would emit 25 million tonnes of CO₂ emissions (plus a negligible amount [1,308 tonnes CO₂] from combustion of crude oil). Taking the median “best” estimate of 3.34 million tonnes of CO₂e of industry emissions associated with the production and processing and natural gas, the gas industry emissions are equivalent to 13.1 percent of the end-use combustion emissions. This percentage is in line with or below other estimates of ancillary emissions from the upstream production and processing of natural gas.⁴

Fig. 7. Comparing gas industry emissions to full combustion of marketed natural gas.



⁴ The combustion of the carbon contained in the fuels produced in La Plata is hypothetical. The calculation is based on marketed production (430 Bcf), does not account for NGL production, assumes full combustion of the end use fuels (whereas liquids are assumed by the EPA and IPCC to be 99 percent combusted, and gas 99.5 percent), and, more importantly, the calculation does not account for non-fuel uses of the marketed products, some of which may be used as pipeline fuel or refineries downstream. Nonetheless, it is a useful comparison of ancillary emissions from gas production detailed in this report and the potential emissions from the fuels produced in La Plata county.

Conclusions

CMS has modeled and estimated carbon dioxide and methane emissions from the operations and facilities of the gas industry in La Plata county. The model is based on official and industry estimates of emissions in New Mexico. CMS has computed emission *rates* per billion cubic feet (Bcf) of natural gas produced in the San Juan Basin underlying northwestern New Mexico and La Plata county. CMS compared New Mexico emission rates of both CO₂ and CH₄ to U.S., Colorado, and other gas industry emission estimates. CMS determined that New Mexico's emission rates are reasonably associated to La Plata, in that both regions have high proportions of coal bed methane with high entrained-CO₂ content. The opportunity exists to articulate and advance further differentiation between industry practice and emission rates in New Mexico and La Plata in future emissions estimates.

CMS calculates La Plata's emissions in the "best" (median) estimate as 24.3 percent lower than the New Mexico model. In the absence of published industry data, county, state, or operator emissions inventories, the CMS methodology is reasonable given the paucity of extant greenhouse gas estimates.

The present result should be considered a first approximation that is likely to be improved in consultation with industry representatives and with the publication of comprehensive industry inventories based on carefully monitored emissions or models built from the field up.

CMS' "best" (median) estimate of total greenhouse gas emissions from the natural gas industry in La Plata county totals 3.34 million tonnes of CO₂ equivalent (MtCO₂e) in 2006 (3.69 million tons CO₂e). The "low" estimate is 2.27 MtCO₂e, and the "high" estimate is 4.42 MtCO₂e.



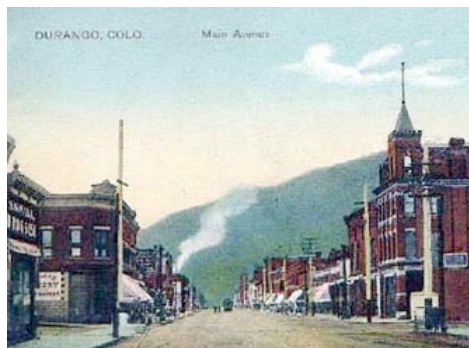
Arkansas Loop Plant, central La Plata. Photo by Jerry McBride, *Durango Herald*, 30Dec05.

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Notes



La Plata gas industry GHG emissions: methodology and results

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