S&P Global
Platts

NORTH AMERICAN EMISSIONS SPECIAL REPORT

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Understanding the Importance of Measuring Methane Emissions and its Impact on the Ongoing Energy Transition

- **On April 1st, 2022, S&P Global Commodity Insights launched new monthly Methane Intensity calculations and corresponding daily methane intensity premiums for 19 separate US natural gas production basins, bringing much-needed visibility to the actual volume of emissions generated through fossil fuel production.**
- **Improved monitoring technology over the last several years has shown that previous methods of measuring the amount of methane generated through US natural gas has under-estimated the true volume of methane that is generated by most industries, including the production and transport of fossil-fuel derived natural gas.**
- **The methane intensity of natural gas production is calculated as the volume of methane emitted as a percentage of total production. Measuring the methane intensity percentage is one way of gauging and measuring the single largest generator of greenhouse gasses (GHGs) in the natural gas production process.**

As the world continues to transition towards cleaner energy production and consumption, methane, a colorless, odorless flammable gas which is a major component of fossil fuel-derived natural gas will remain a focal point for the foreseeable future as efforts to combat global warming grow.

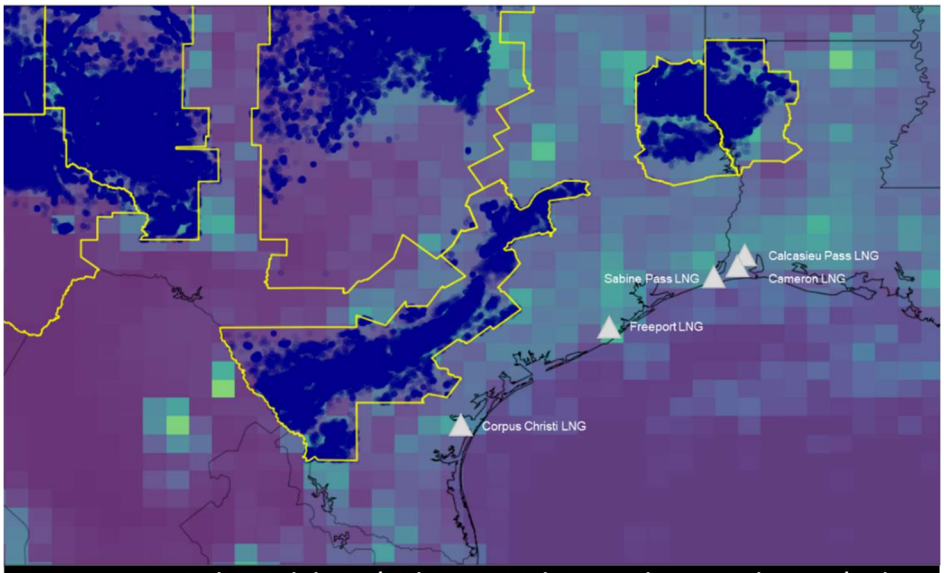
The transition away from coal in power generation over the last twenty years has resulted in a sharp increase in natural gas production and, by extention, has contributed to a sharp increase in the amount of associated methane in the atmosphere. While the increase in natural gas production and combustion over the last several decades is not the sole contributor to the rise in atmospheric methane emissions, it is one of the largest factors. The global warming potential (GWP) of one metric ton of methane released unburned into the atmosphere over a 100-year period can be between 28 to 36 times higher than one metric ton of CO_2; and it is between 84 to 87 times more potent than CO_2 in the first 20 years of its life cycle within the atmosphere. Tackling the methane emissions generated by oil and natural gas production and combustion as well as the methane vented by other industries is one of the most significant things that can be done to slow the rate of climate change in the immediate term.

One of the more potentially significant accomplishments to come out of COP26 in November 2021 was when the US and the EU jointly announced The Global Methane Pledge, signed by 100 countries, to cut global methane emissions by 30% from 2020 levels by 2030. Additionally, on August 16th 2022, the Inflation Reduction Act (IRA) was signed into effect in the US, which includes a charge on methane emissions from certain facilities in the oil & gas industry. Facilities that are subject to this methane emissions charge are those that are already required to report their greenhouse gas emissions to the EPA's Greenhouse Gas Emissions Reporting Program. Based on the CO_2 prices outlined in the table below, using the 100-year GWP index, the charge would be $900 per metric ton of methane for the first year, increasing to $1,500 per metric ton of methane after two years, marking the first time the US government will impose a charge, fee or tax on greenhouse gas emissions.

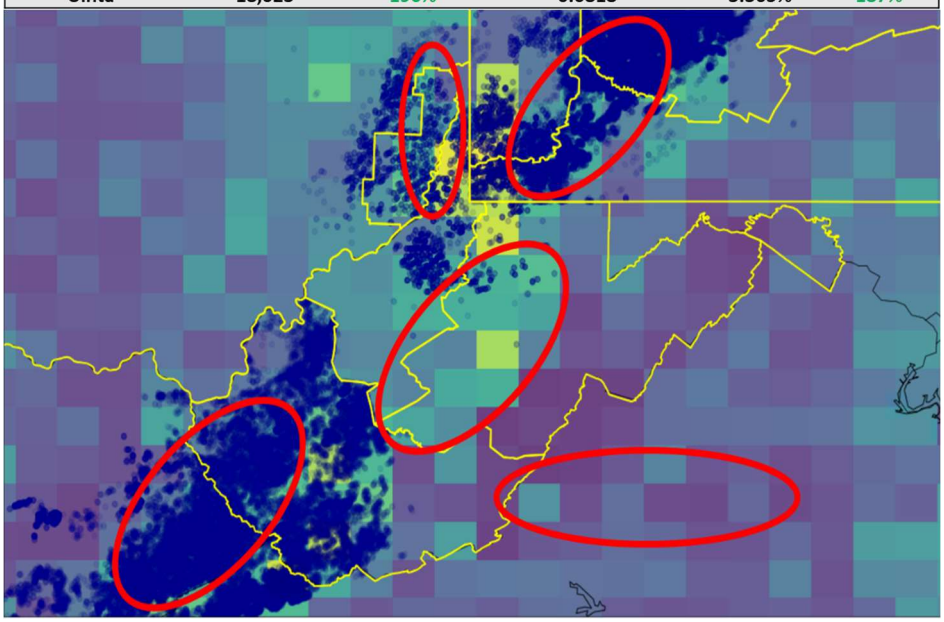
IRA Methane Charge Rates				
Methane Charge Measure	**2024**	**2025**	**2026**	**After 2026**
$/metric ton of CH_4 emissions @ 100 year GWP x 25	$ 900	$ 1,200	$ 1,500	$ 1,500
$/metric ton of CH_4 emissions @ 20 year GWP x 87	$ 3,132	$ 4,176	$ 5,220	$ 5,220
$/metric ton of CO_2 equivalent	$ 36	$ 48	$ 60	$ 60

The IRA charge rate estimates are based off of the 100-year GWP index, however, considering that the global warming potential of one metric ton of methane released into the atmosphere is between 84 to 87 times more potent than carbon dioxide in the first 20 years of its lifecycle, over three times as much as the 100-year GWP, charging methane emissions at a 20-year GWP rate, would significantly increase the methane charge, and could significantly increase the urgency to reduce methane emissions. Although efforts towards assessing and reducing methane emissions continue to gain momentum, the practicalities of accomplishing this are proving to be a bigger challenge because the scope of the methane problem is much larger than realized and impacts commodities and industrys beyond just oil & gas.

The US Environmental Protection Agency has been trying to document methane emissions from various industries for years, relying on a "self-reported" model, wherein total emissions data is extrapolated from a subset of reporting businesses and scaled up. Historically, this self-reported



Basins	Methane Emissions (mt/Month)	M/M Change (% Change)	Methane Intensity (tonnes of CO2e/MMBtu)	Methane Intensity (%)	M/M Change (% Change)
ARKLA-Haynesville	27,671	-19%	0.0079	0.587%	-22%
ETX-Haynesville	29,414	-20%	0.0155	1.135%	-25%
Appalachian-OH	27,839	3%	0.0121	0.865%	-11%
Appalachian-PA	93,314	-13%	0.0123	0.918%	-11%
Appalachian-WV	60,924	20%	0.0216	1.565%	7%
Ft-Worth	59,093	28%	0.0657	4.506%	16%
Bakken-US	28,066	-14%	0.0252	0.631%	-18%
Eagle Ford	37,850	-34%	0.0151	0.614%	-34%
Permian-Delaware	28,925	-54%	0.0064	0.220%	-56%
Permian-Midland	48,162	-12%	0.0187	0.502%	-15%
SCOOP-STACK	26,572	-62%	0.0142	0.790%	-64%
Denver-Julesburg	37,366	17%	0.0333	1.416%	10%
Powder-River	27,539	-2%	0.1195	3.709%	-11%
Anadarko	92,052	-45%	0.1138	6.868%	-45%
Piceance	24,787	25%	0.0475	3.408%	31%
Arkoma	40,263	-15%	0.0482	3.531%	-20%
San Juan	31,677	49%	0.0435	3.068%	43%
Green River	13,017	31%	0.0123	0.872%	21%
Uinta	18,023	196%	0.0818	3.365%	187%



data has been estimated, which has left it open to concerns about under-reporting of overall emissions. As measuring technology has improved over the last decade, it has become clear that the release of methane across different activities has historically been under-reported.

Accurate measurement of methane emissions across different activities is critical to guage how effective measures are that are designed to reduce emissions. S&P Global Commodity Insights has begun publishing monthly methane intensity data that use satellite modelling to focus in on nineteen natural gas production basins in the continental US to get a more accurate picture of what is being emitted within a specific geographical area.

Methane intensity is calculated by looking at the volume of methane emitted as a percentage of total natural gas production in a given region. Measuring an odorless and colorless gas that disperses into the atmosphere based on the weather patterns at the time of release, means that pinpointing exactly where, and more importantly how much, methane is being leaked is extremely difficult to quantify, even with contiuous monitoring in place.

The S&P Global Commodity Insights approach to measuring methane intensity takes a top-down approach by focussing its satellite model directly on the oil and gas producing facilities within each production basin, and it largely compliments the bottoms-up approach that uses well-head sensors and other types of real-time monitoring to get a more accurate picture of what is being emitted throughout the production process. The top image illustrates observed methane emissions over several basins (yellow polygons) using our satellite model, overlayed with actively producing oil & gas wells (blue dots).

But what is also clear is that neither approach is perfect because methane emissions are a by-product of so many other sources outside of just oil & gas operations, such as enteric fermentation (live-stock), coal mining operations, landfills, manure management and more. That said, with increased focus, improvements in satellite tech-nology and increased real measurement at the potential sources across all industries will help improve the understanding of how methane disperses within the atmosphere, helping all industries

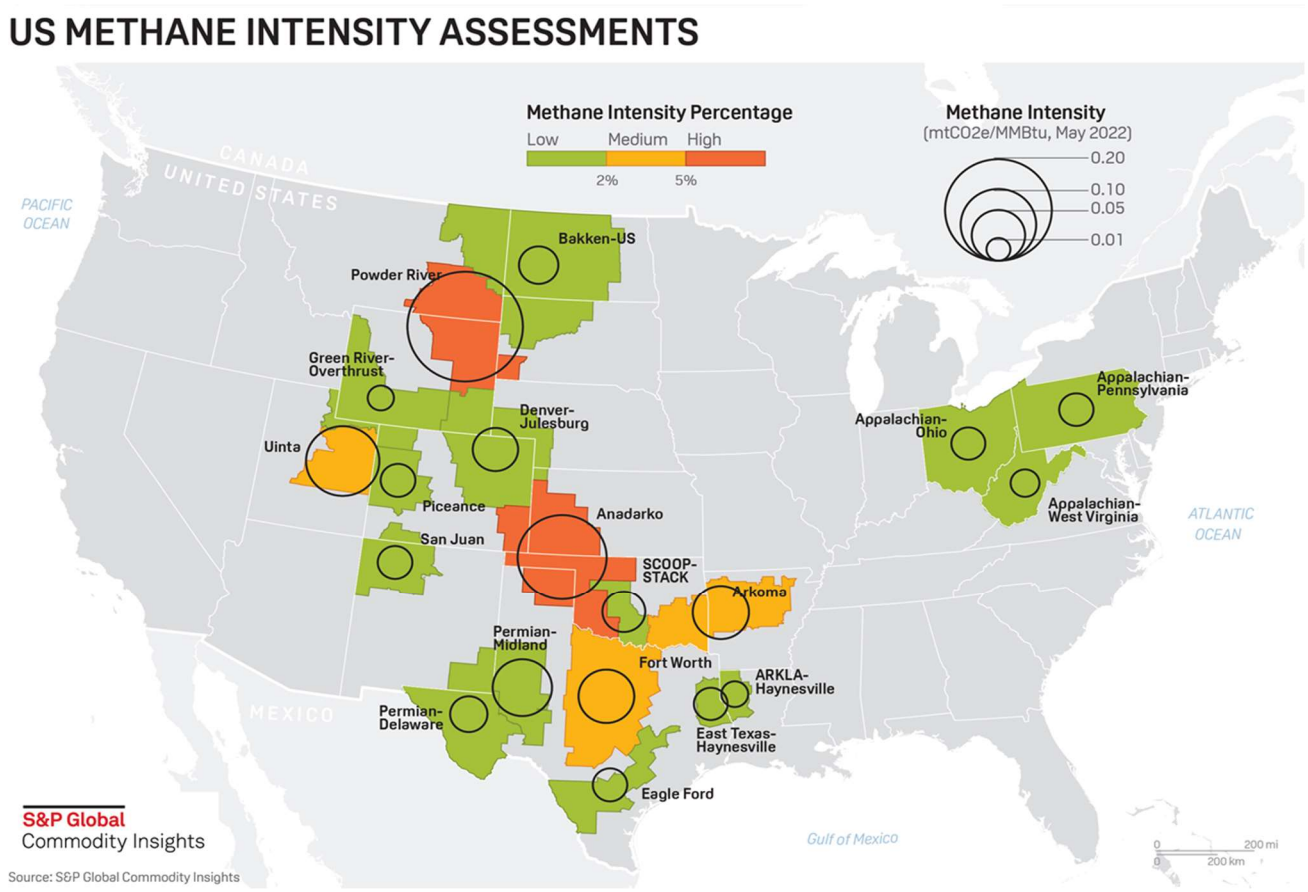
determine how to limit and reduce the amount of methane being emitted in the first place.

The table illustrates S&P Global Commodity Insights' latest methane assessments for the month of July. The largest methane emitting regions in July were Appalachian Pennsylvania and the Anadarko basin, coming in at 93,314 mt/month and 92,052 mt/month, respectively.

Although methane intensity from oil & gas operations in the Appalachian basin has generally been observed to be less than most US basins in studies, the high methane emissions value is likely attributed to emissions from other sectors such as coal mining, dairy farms, power generation and larger population centers nearby which potentially inflate this assessment as it relates to oil & gas operations.

In support of this potential explanation, the second satellite model image highlights methane emissions spread across the Appalachian with actively producing wells in blue and pockets of concentrated coal mining operations circled in red, illustrating that methane is not just an issue for oil & gas operations but rather one that affects several other sectors and industries.

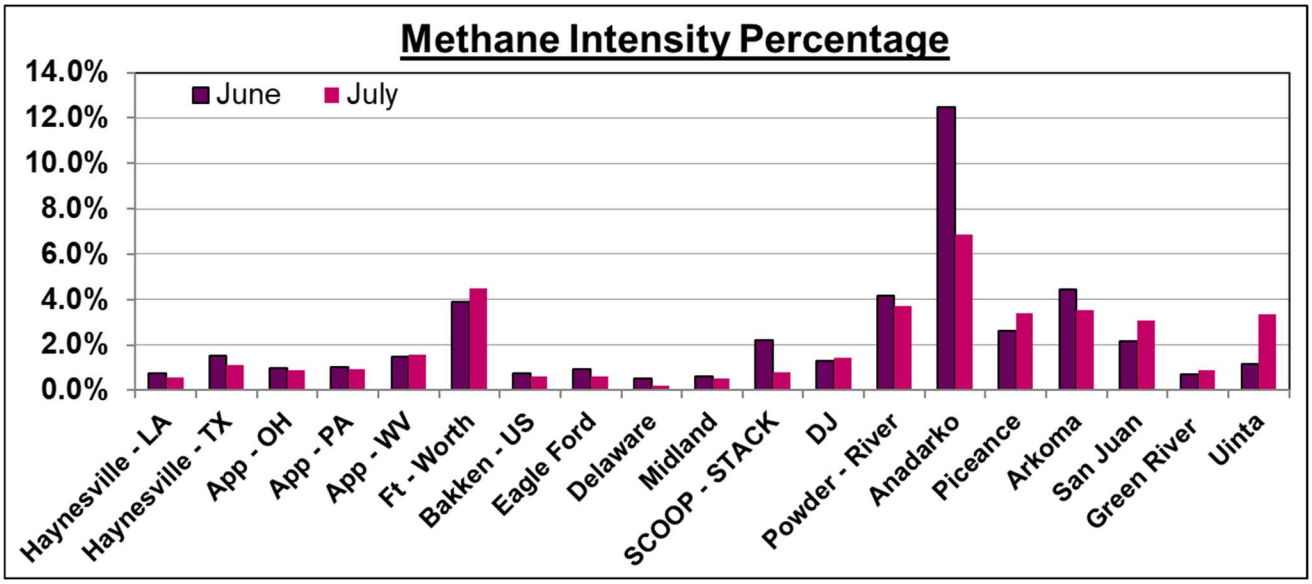
Meanwhile, high emissions in the Anadarko basin are likely correlated to more intensive production recovery methods, older producing field and infrastructure, and a more methane-intensive geologic formation. As for methane intensity percentage, Anadarko and Fort Worth had the highest intensities for the month of July coming in at 6.87% and 4.51%, respectively.



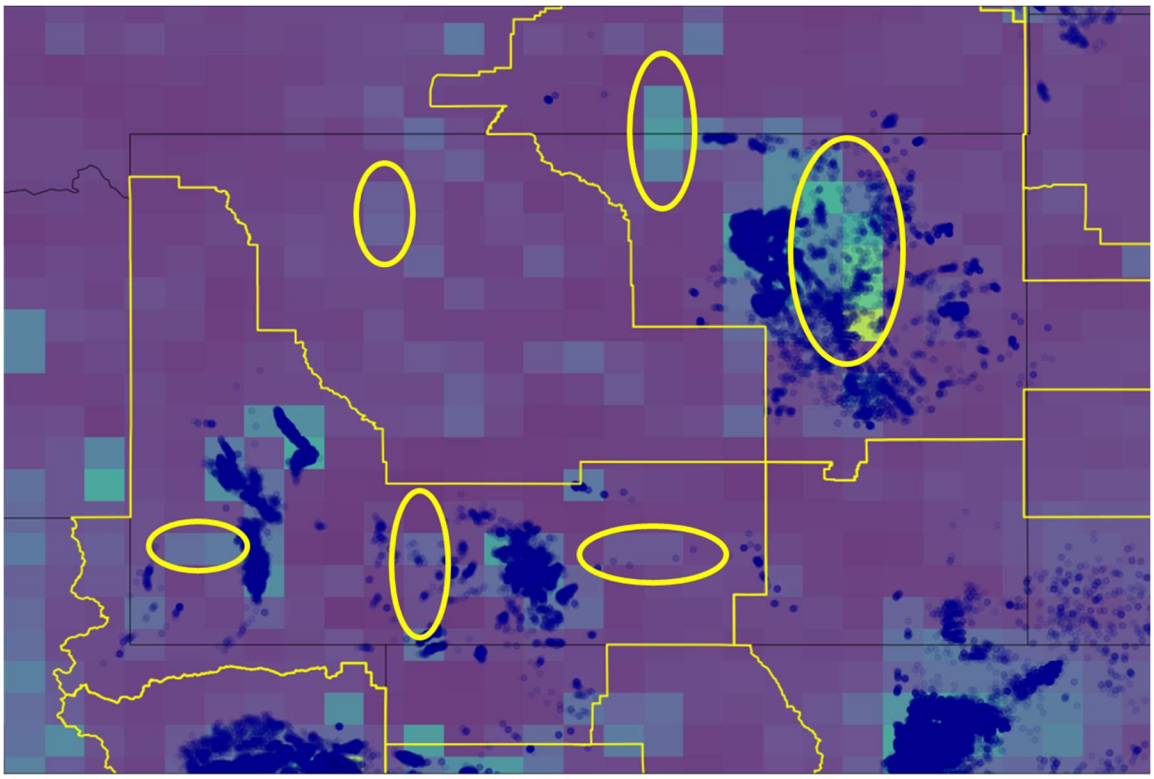
On the flip side, methane emissions were the lowest in the Green River basin and Uinta basin at 13,017 mt/month and 18,023 mt/month, respectively, potentially driven by less active oil & gas operations compared to other basins, less influence on overall emissions from other sectors, smaller population and more weather interference via clouds and wind.

The Permian – Delaware and Permian-Midland basins had the lowest recorded methane intensities for the month of July coming in at 0.22% and 0.50%, respectively. Despite recording the lowest methane intensities in July, this can be misleading as methane intensity is a function of production output, which both basins have produced within the top 5 largest natural gas producers amongst the 19 regions being assessed.

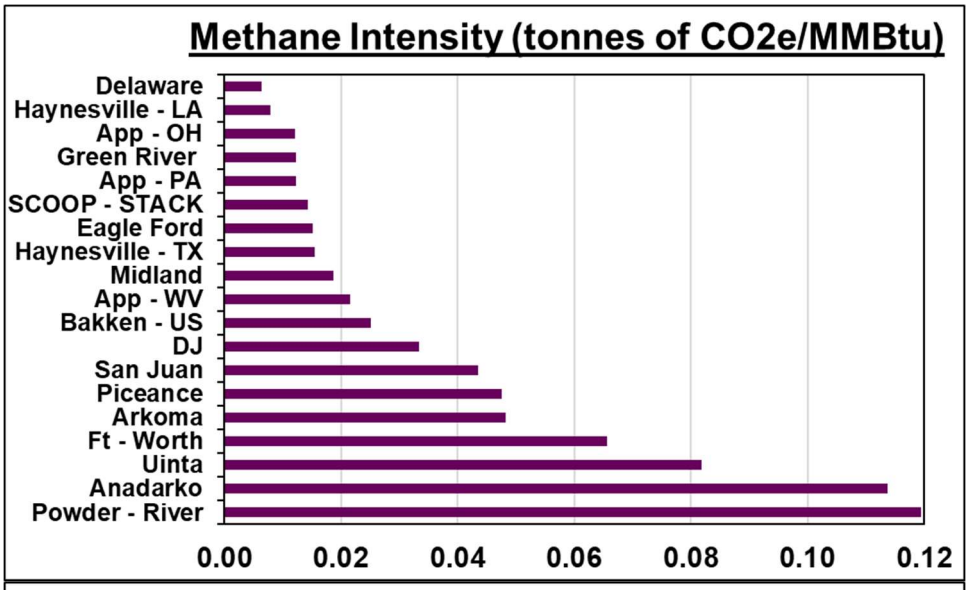
Additionally, these two regions do not have as many other facilities from other sectors aiding to the overall emissions estimates nor do they have as large of population centers within them compared to other regions.

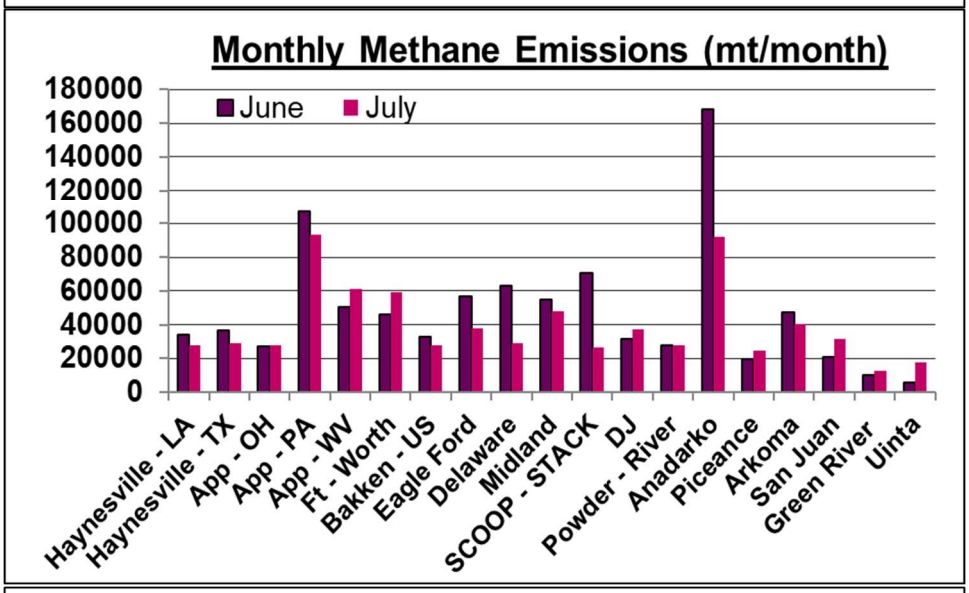


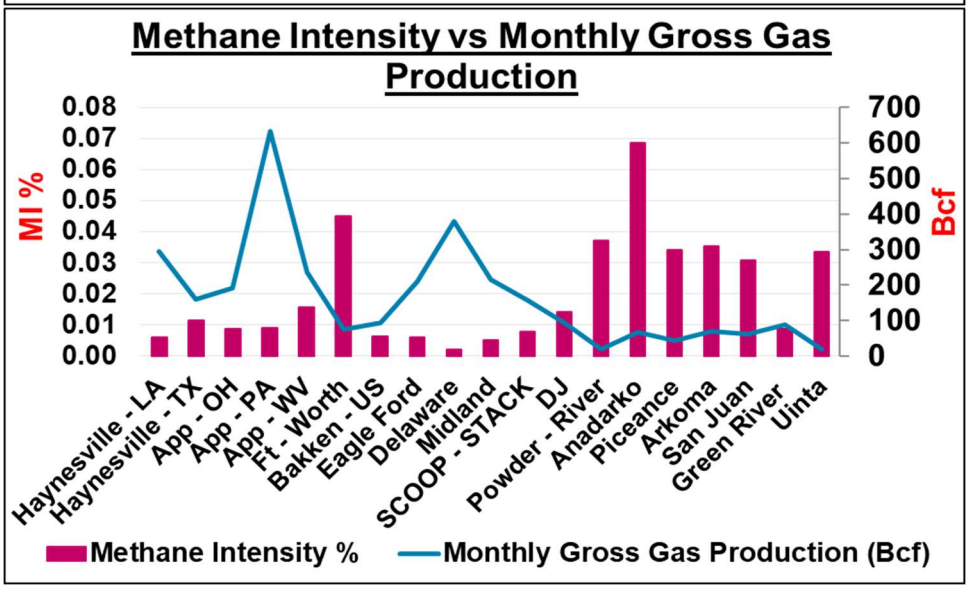
Methane intensities ranging within the middle-to-upper end include basins within the Rockies/Mid-continent regions consisting of Powder River basin (3.71%), Arkoma (3.53%), Piceance (3.41%), Uinta (3.37%) and the San Juan basin (3.07%). Like the Appalachian region, the Powder River basin assessments are likely partially inflated by neighbouring emissions from coal mining operations. As shown in the image below, pockets of concentrated coal mining operations across Wyoming (circled in yellow) are often nearby producing oil & gas wells (blue dots) resulting in mixed methane emissions from both sectors once released into the atmosphere, which is applicable to what is occurring with other nearby facilities from other industries, reinforcing the need to obtain higher granularity satellite imaging while maintaining a robust portfolio of different sources for methane emissions data, something that Commodity Insights' will continue to monitor as part of the methane intensity assessments.



Elevated methane intensity percentages for Arkoma, Piceance, Uinta and San Juan basins are partially influenced by more carbon intensive geologic formations that typically require enhanced recovery methods to maintain a profitable amount of production, older infrastructure in place and less production output which factors into higher methane intensity percentages.







On the middle-to-lower end of the methane intensity spectrum, we observe basins like Appalachian West Virginia (1.57%), Denver-Julesburg (DJ, 1.42%), East Texas-Haynesville (1.14%), Appalachian Pennsylvania (0.92%) and ARKLA-Haynesville (0.59%). In addition to lower assessed methane intensities for these basins, several operators in each of these regions have committed to certifying a portion of, if not most of their produced natural gas, supporting overall lower regional intensity of gas in these basins, a trend that is likely to continue as the producer certified natural gas movement continues to grow. Some of these states have also seen significant state regulations that limit the amount of flaring and methane permitted and have therefore seen an overall reduction.

As shown in the bottom graph, lower methane intensity percentage maintains a strong correlation with basins which produce larger quantities of natural gas. Despite this trend, this does not particularly correlate lower methane emissions with basins that have achieved lower intensities. Larger natural gas production output from basins has typically been more forgiving on methane intensities across the US.

Although it remains a challenge for top-down satellite approaches to differentiate emissions from varying facilities via other sectors, S&P Global Commodity Insights is continuing to explore multiple solutions including diversification and optionality of integrating multiple data sources to assess methane emissions and integrating a combined top-down/bottoms-up approach.

As the race to reduce methane emissions in the US and globally continues to take-off, S&P Global Commodity Insights will continue to monitor ongoing development of current methane regulations in support of intensity assessments, Methane Performance Certificates, Methane Intensity Premiums, as well as work on the refinement, reinforcement and expansion of all our methane analysis.

FAQ & Methodology

What is methane intensity and how are we measuring it?

The methane intensity of natural gas production is calculated by looking at the volume of methane emitted as a percentage of total production. Measuring methane intensity is one way of gauging and measuring the single largest generator of greenhouse gasses (GHGs) in the natural gas production process. We are publishing the methane intensity of 19 natural gas production basins in North America on a monthly basis as:

- **methane emitted as a percentage of total production (MI% of total production)**
- **metric tons of methane per MMBtu (mtCH4/MMBtu)**
- **metric tons of carbon dioxide equivalent per MMBtu (mtCO2e/MMBtu)**

The Commodity Insights methane emission rate calculation is derived from daily methane concentration data collected by the Copernicus Sentinel – 5P satellite using the TROPOspheric Monitoring Instrument (TROPOMI). We estimate the methane emission rate with a top-down atmospheric inversion framework using GEOS-Chem simulation to conduct monthly perturbation analysis of historical emission inventory dataset for each area of interest.

All three Methane Intensity calculations are published for the month prior rolling on the third Monday of each month. For example, on September 19 2022, we will publish MI data for the month of August 2022.

This process reflects a more accurate rate for methane emissions within these production basins and can differ from self-reported data or real-time monitoring processes for individual projects within each region. Commodity Insights has focused its satellite model directly on the oil and gas producing facilities within each production basin to get the most accurate picture of the methane emissions rate generated by the US natural gas industry. However, because methane emissions are often a by-product of numerous other industries – including power generation, mining, and agriculture – and methane disperses within the atmosphere, the methane intensity calculations will capture some additional emissions data from other industries.

What is a Methane Intensity Premium and how is it calculated?

In addition to the three methane intensity calculations, Commodity Insights is also publishing methane intensity premium (MIP) calculations for all 19 production basins in both $/MMBtu and $/mtCO2e. Unlike the MI calculations, the MIP calculations will be published on a daily basis and reflect a 1330 US Central Standard timestamp.

MIPs calculate the cost of bringing the methane intensity of one MMBtu of average natural gas production per production basin to 0.

They are calculated by multiplying the methane intensity of each basin by the daily price of the Platts Methane Performance Certificate assessment (AMPCA00), which represents one MMBtu of zero methane intensive natural gas production.

MPCs are traded separately from physical natural gas and are generated by natural gas produced with a demonstrated methane emissions intensity at or below the Commodity Insights threshold of 0.10%; the current average methane intensity for US natural gas production is 0.437%.

How do the Methane Intensity Premiums fit with other natural gas and energy transition markets?

As the world has become more aware of the dangers presented by escalating climate change, it has become increasingly clear that real, measured approaches to carbon accounting are critical across a number of different industries. Our use of real-time satellite and natural gas production data to generate its methane intensity calculations will provide much-needed clarity around the actual rate of methane being emitted through US natural gas production, while the MIPs will bring pricing transparency to the financial cost of continued methane emissions and encourage faster mitigation practices.

The new methane-specific numbers will compliment our existing Americas natural gas assessments. Additionally, they are also the latest addition to our suite of fossil fuel carbon intensity calculations, which already cover 104 crude fields globally and Australian LNG production.

Additional questions?

If you have any additional questions please reach out to Deb Ryan, Low Carbon Commodities Manager (deb.ryan@spglobal.com) or Emmanuel Corral, Low Carbon Gas Analyst (emmanuel.corral@spglobal.com).