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METHANE EMISSIONS IN ROMANIA'S ENERGY SECTOR

A measurement-informed assessment in the context of the EU Methane Regulation

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Abbreviations

AMM	Abandoned Mine Methane
ANRE	Romanian Energy Regulatory Authority
ANRMPSG	Romanian National Authority for Regulation in the Mining, Petroleum, and Geological Carbon Dioxide Storage Sectors
CA	Competent Authority
CH_4	Methane
CMM	Coal Mine Methane
EEA	European Environment Agency
ESA	European Space Agency
EUKI	European Climate Initiative
EU-MER	European Union Methane Emissions Regulation
E&P	Exploration & Production
GEM	Global Energy Monitor
GMT	Global Methane Tracker
IEA	International Energy Agency
IMEO	International Methane Emissions Observatory
LDAR	Leak Detection and Repair
MRV	Monitoring, Reporting and Verification
MS	EU Member States
NIR	National Inventory Reporting
OGCI	Oil and Gas Climate Initiative
OGMP 2.0	Oil and Gas Methane Partnership 2.0
ROMEO	Romanian Methane Emissions from Oil & Gas
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention for Climate Change

Contents

Executive summary

Overview

Methane (CH_4) is a potent greenhouse gas, with a global warming potential more than 80 times greater than that of CO_2 over a 20-year horizon. In Romania, as across Europe, reducing methane emissions from the energy sector is both an environmental necessity and an economic opportunity. This report presents an independent, measurement-informed assessment of methane emissions from the country's oil and gas sector, while briefly addressing the coal sector. The assessment builds upon the results of the ROMEO[1] campaign, which employed a multi-scale measurement strategy, and on complementary scientific studies that further refine site-level and regional methane estimates for Romania. These combined datasets provide insights to support Romania's implementation of the EU Methane Emissions Regulation (EU-MER) and the continuous improvement of national inventories under the UNFCCC framework (*Romania. National Inventory*, 2024)

Key findings

Regional methane emissions from Romania.

- Based on empirical, measurement-based data from the ROMEO campaigns, Romania's oil and gas sector emitted an estimated 320 kt of methane [220 – 460 kt] in 2019.
- By 2021, measured emissions declined by an estimated 20 – 60 %, suggesting national emissions between 130 – 260 kt methane, reflecting uncertainties linked to the different measurement techniques and regional coverage of the 2021 campaign.
- Extrapolating these trends, 2023 emissions and loss rates remain similar to 2021, at 120 – 235 kt methane, though this remains based on inventory reported reductions, mainly driven by decreased production, rather than measured data.

Results indicate that actual emissions from oil and gas operations are significantly higher than official estimates.

- The analysis shows that official UNFCCC-reported emissions are two to three times lower than the measurement-based estimates for the same years (2019 – 2023).
- The underestimation arises from the use of generic, non-country specific emission factors. A similar discrepancy is observed when comparing with IEA estimates.

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[1] ROMEO is a large measurement campaign to investigate methane emissions from oil and gas production in Romania. The campaign was initiated by the European H2020 project MEMO2 and is also funded through UNEP's IMEO. During the campaign 14 research teams from The Netherlands, UK, Denmark, Germany, Romania, US, Switzerland, Poland, and Sweden will be in the field to measure methane and other atmospheric parameters using instruments placed on two aircraft from Scientific Aviation and INCAS, but also on drones, and in cars.

The analysis identifies significant data gaps across infrastructure mapping, operational activity, and direct emissions measurement. Publicly available geospatial and facility-level datasets remain limited.

Inactive and abandoned wells represent a potentially important but unquantified source. Romania's initial EU-MER inventory includes ≈47,390 wells, with only ~20 % included in the national inventory so far.

Methane emissions from active and abandoned coal mines remain poorly quantified in Romania, with current estimates based solely on generic emission factors, introducing high uncertainty. Preliminary assessments, based on a Bayesian inference framework developed by UNEP'S IMEO, suggest actual emissions from active mines may exceed reported values, while emissions from abandoned underground mines are likely significant but unmeasured.

Measurement-based data are indispensable for establishing credible national baselines and for verifying industry reporting under the EU Methane Emissions Regulation (EU-MER). Without regular empirical updates, reliance on generic emission factors introduces major uncertainties in both policy design and mitigation planning and makes it challenging to track mitigation progress.

1. Introduction

Methane (CH_4) is a greenhouse gas with a global warming potential more than 80 times that of CO_2 over 20 years, and the energy sector is one of its largest anthropogenic sources. The EUKI project 'Implementing the EU Methane Emission Regulation' ("Implementing the EU Methane Emission Regulation, EUKI," n.d.) to which this report belongs, aims to accelerate methane reduction in Romania and Czechia by promoting the effective implementation of the EU Methane Regulation (European Commission, 2024). Based on data reported to the United Nations Framework Convention for Climate Change (UNFCCC), together, Romania and Czechia contribute roughly 25 % of the EU's domestic methane emissions from the energy sector and face challenges due to limited institutional capacity that may lead to a poor implementation of the mechanism in both countries. Moreover, public authorities and civil society may face difficulties in interpreting emissions data reported by operators under the EU-MER. The reliability and usability of such data can be substantially enhanced by integrating measurement-based datasets across multiple spatial and temporal scales.

Particularly, this report aims to provide a regional assessment on methane emissions in Romania based on the best available empirical and measurement-based data. It compiles reliable, independent estimates from multiple scientific studies and measurement campaigns to establish a national methane emissions baseline for Romania's energy sector. This baseline will serve as the scientific basis for further work within the project that will analyze the costs and benefits from applying methane reduction measures with an independent economic analysis that shows the business case for reducing methane emissions from the energy sector.

EU Methane Emissions Regulation

The EU Methane Regulation (EU-MER) entered into force in August 2024 and is the first EU comprehensive legal framework targeting methane emissions across oil, gas and coal activities, both from domestic operations and from imports, and it is directly applicable in all Member States. Member States are responsible for designating Competent Authorities (CA) to oversee implementation, receive and verify operator reports, conduct inspections, and enforce compliance (including penalties for non-compliance). The Regulation establishes rules for Monitoring, Reporting and Verification (MRV), Leak Detection and Repair (LDAR), limitations to venting and flaring, and transparency for domestic operators and importers. With its measurement-based approach, the Regulation aims to create a robust, measurement-based foundation for methane emissions reporting, enhancing transparency and driving emissions reductions in the EU and across international producers in the oil, gas and coal sectors.

The measurement and reporting provisions of the Regulation are designed to ensure that methane emissions are reported using reliable and accurate data. For methane emissions in the oil and gas sectors, Article 12 of the EU-MER establishes the foundation for a progressive transition toward robust, measurement-based reporting, moving beyond generic estimates to empirical quantification of emissions. The use of generic emission factors in inventories is known for significantly underestimating actual methane emissions, which depend on many factors including operational practices (e.g., Alvarez et al., 2018; Riddick & Mauzerall, 2023). In the context of the EU-MER MRV provisions, domestic operators must submit annual reports of methane emissions from oil and gas upstream, midstream, and downstream activities. Reported emission

estimates must be based on direct measurements where feasible, particularly source-level measurement-based quantification (due in February 2026) and source-level emissions estimates reconciled with site-level measurements (due February 2027 and by 31 May every year thereafter). Emissions reporting must cover the last available calendar year period and must be assessed by a third-party verifier that is accredited by national authorities. The regulation sets out transparency requirements, mandating that CAs make the reports available to the public and to the Commission. According to Article 30, the Commission should set up a "Methane Transparency Database" with the information reported by domestic operators and importers. This will ensure comparability and enable independent verification, as well as contribute to enhancing transparency for buyers in the Union, allowing them to make informed decisions.

Role of independent measurement-based methane data

Independent measurement-based methane data plays a central role in providing an accurate characterization of methane emissions from production regions, providing unbiased and verifiable evidence that supports the development, implementation, and enforcement of emission standards [OGMP as the basis for regulation, 2025]. The integration of advanced measurement technologies, including ground-based monitoring, aerial surveys, and satellite observations, provides a comprehensive characterization of methane emissions from entire production regions and supply chains, enhancing the reliability of emission estimates. To the extent possible, verifiers should perform an empirical verification: in addition to assuring compliance with reporting guidelines, they should incorporate independent, measurement-based data to assess any discrepancies in the emission estimates provided by operators. CAs should also consider using this data at larger scales (i.e., regional level) to provide an initial baseline assessment of emissions. This approach further incentivizes improvements in data quality and enhances CAs' ability to validate the reconciliation process. In accordance with the Regulation, competent authorities, verifiers, and the Commission are encouraged to consider internationally available information such as that provided by the International Methane Emissions Observatory (IMEO) when assessing methodologies for data aggregation, analysis, and verification of methane emissions quantification.

Regional methane context

The European Environment Agency (EEA), based on data reported by EU Member States under the EU Governance Regulation, which reflects the greenhouse gas inventory as reported under the UNFCCC, estimated that in 2023 agriculture accounted for 39 % of total methane emissions in Romania, followed by energy at 34 %, and waste at 24 % (see Figure 1). In Romania, methane reporting to the UNFCCC is based primarily on activity data combined with default, non-country specific emission factors, rather than on direct, measurement-based estimates. This approach introduces notable uncertainty, particularly in the oil and gas sector, where emissions can be highly variable and episodic. Multiple studies worldwide, including in Romania, have shown that methane emissions from the oil and gas sector are systematically underestimated in official inventories, sometimes by a factor of two or more (e.g., MacKay et al., 2021; Riddick & Mauzerall, 2023; Stavropoulou et al., 2023; Tibrewal et al., 2024).

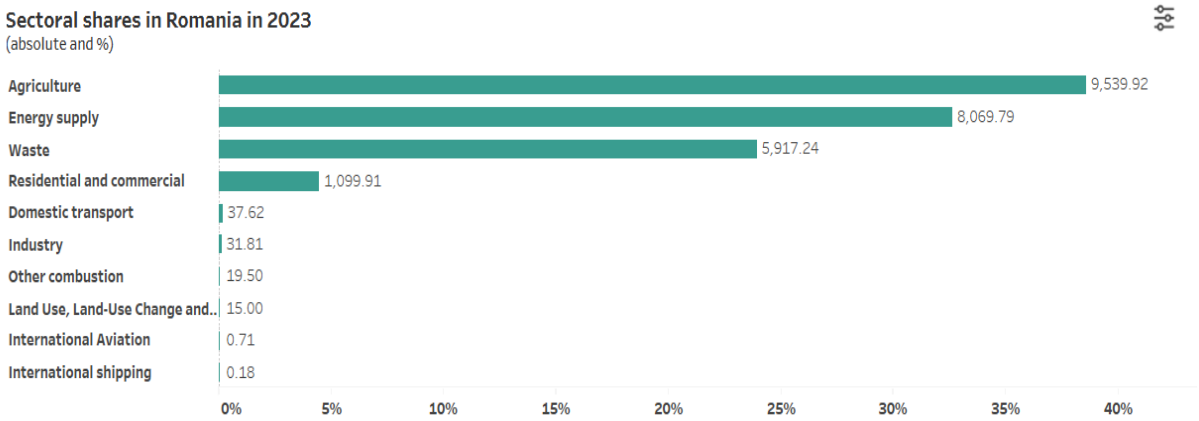

Figure 1. Methane emissions in kt CO2eq from all sectors in 2023 in Romania. Source: European Environment Agency based on the country reporting to UNFCCC.

The energy sector represents one of the dominant sources of anthropogenic methane emissions in Romania. Within the energy sector, emissions arise primarily from oil and gas production, processing and transmission activities, and from coal mining operations. Romania is among the top oil and gas producers in the European Economic Area. In 2023, it was the third oil producer after Norway and Italy and the second natural gas producer after Norway, even surpassing the Netherlands as the largest producer in the European Union (source: IEA, Eurostat). The offshore Neptun Deep project in the Black Sea, once operational (expected around 2027), is projected to significantly increase Romania's gas production. Domestic energy production is largely dominated by natural gas, followed by biofuels and waste, oil, coal, and other sectors (source: IEA country profile for 2023). Besides emissions from oil and gas, the European Regulation also targets methane emissions from coal mines. According to the IEA, Romania ranks 10th in coal production in the European Region and 5th in the EU, with coal accounting for 14 % of total electricity generation in 2023. Each of the energy subsectors presents distinct emission mechanisms and mitigation opportunities. From an economic point of view, there is strong evidence that methane recovery from coal mines (e.g., through degasification systems for power generation) is a profitable activity for both the mining company and a possible investor (Chiuzan & Matei, 2024). The oil and gas subsector has a high mitigation potential with significant opportunities for cost-effective reductions. Methane is released from leaks, venting and flaring, spanning extensive infrastructure systems that include thousands of wells, processing facilities, and transmission pipelines. Technical abatement possibilities are reasonably well established, which means that targeted interventions can achieve more immediate and cost-effective opportunities for emission reductions. According to IEA estimates (*Global Methane Tracker 2025 – Analysis*, 2025) and within a global perspective, methane emissions could be reduced by almost 70 % at nearly no net cost to the industry. Given this context, this report primarily focuses on methane emissions from Romania's oil and gas subsector, while also briefly addressing coal-mine emissions for completeness. The oil and gas sector's operational relevance makes it a critical target for near-term emissions reductions, and the existing technological solutions enable rapid, measurable progress towards mitigation.

The independent assessment of Romanian regional methane emissions in this report serves as a baseline for Romania's methane footprint, key for policymakers for targeted and efficient mitigation. It can also be used by policymakers to verify reported emissions under the EU-MER and to track progress on methane emissions reductions based on empirical and accurate data.

This baseline will be updated as more recent and measurement-based reporting becomes available as expected with the regulation.

The report is structured as follows: Section 2 outlines the data sources used to assess methane emissions. Section 3 presents Romania's sectoral methane profile, focusing on oil and gas and briefly addressing coal. Section 4 discusses key results and uncertainties, while Section 5 concludes with policy and economic implications. Finally, Section 6 provides an outlook and summary of next steps for this report.

2. Methods and materials

In this section, we provide a general overview of the data sources we have used for the assessment of the regional emissions presented in Section 3. These data sources include inventories, science studies and operators' sustainability reports that provide context, empirical emissions data, asset and production information and insights. More details and information can be found in the respective links and references within the text.

To provide an overall understanding of Romania's reported methane emissions, we use the UNFCCC national inventory, and the IEA Global Methane Tracker. United Nations Framework Convention on Climate Change (UNFCCC) national inventories are compiled by individual countries and represent official methane emissions reporting. The UNFCCC inventory is submitted annually, and emissions are estimated using IPCC 2006 guidelines with a combination of Tier 1, Tier 2 and Tier 3 methodologies, incorporating detailed country-specific data where available. The most recent submission from Romania to the UNFCCC, the 2025 National Inventory Document (*Romania. National Inventory*, 2025) includes greenhouse gas emissions reported for the year 2023. While UNFCCC data are the most authoritative for official reporting and international climate accounting, they are subject to uncertainties due to limited direct measurements and reliance on generic emission factors.

Science studies

Prior to 2019, no empirical data of methane emissions from the oil and gas sector in Romania were publicly available, and all reported inventory estimates relied on generic, non-country-specific emission factors. The first scientific study addressing this gap was conducted in 2019 through the Romanian Methane Emissions from Oil & Gas (ROMEO) project, funded by the Climate and Clean Air Coalition (CCAC) Oil & Gas Methane Science Studies (MSS) under the United Nations Environment Programme (UNEP). The ROMEO campaign aimed to survey Romania's main onshore oil and gas regions, covering scales from street-level surveys in cities to measurements at individual production sites and across extensive production areas. Two additional measurement campaigns followed in 2021, also under the ROMEO umbrella.

To assess methane emissions and their sources, a variety of quantification approaches were applied, summarized in Figure 2. For local natural gas distribution systems, street-level measurements were carried out in the urban areas of Bucharest and Ploiesti using multiple vehicles, with source attribution supported by isotopic analysis and ethane-to-methane ratio measurements (Fernandez et al., 2022). Measurements in the oil and gas fields focused on the country's highest-production regions, namely southern Romania (oil-focused production region) and Transylvania (gas-focused production region), to capture emissions from the most significant oil and gas operations. Together, these complementary methods provided a comprehensive, multi-scale assessment of methane emissions across Romania's most important natural gas and oil sectors.

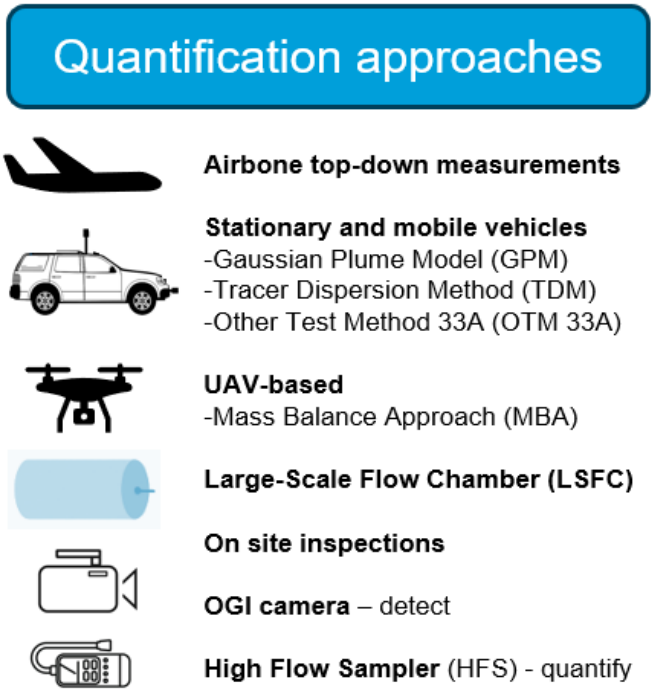

Figure 2. Measurement and quantification approaches used during the 2019-2021 ROMEO campaigns. These included stationary and mobile vehicle-based and Unmanned Aerial Vehicle (UAV)-based methods, a prototype Large-Scale Flow Chamber (LSFC) and onsite inspections (Delre et al., 2022) (Korbeń et al., 2022) (Stavropoulou et al., 2023) (Jag

oda et al., 2025). Top-down evaluation of CH_4 emissions across southern Romania were also part of the campaign (Maazallahi et al., 2025) (Kuhlmann et al., 2025).

Other data sources

The International Energy Agency (IEA) is an intergovernmental organization working with governments and industry to provide data, analyses and reports on global energy systems, in support of a sustainable energy transition. The IEA website contains both publicly available and proprietary datasets on many aspects of the global energy sector and makes reports and data visualizations available on their website. Its main contribution to energy methane research consists in the yearly compilation of a Global Methane Tracker (GMT), estimating global methane emissions from the energy sector. The GMT estimates oil and gas methane emissions using U.S.-based emission intensities derived primarily from inventories and, where available, measurement studies, which are then scaled globally using country-specific data such as infrastructure age, operator types, flaring intensity, and satellite detections of super emitters. Similarly, for coal, mine- or region-specific intensities from major producers (China, India, the United States, and Australia) are developed, with estimates for other countries adjusted using this data alongside factors such as coal type, mine depth, and regulatory oversight.

OMV Petrom and ROMGAZ, the main Romanian oil and gas operators, yearly publish a sustainability report. In their 2024 report, OMV Petrom articulates ambitious climate targets, including a 30 % reduction in Scope 1-2 Greenhouse Gas (GHG) emissions and 20 % in Scope 1-3 GHG emissions (relative to 2019), alongside its aspiration to achieve net zero operations by 2050. As part of this transition, OMV Petrom reports a reduction of 80 % in methane emissions intensity compared to 2019 levels, along with significant reduction in flaring and venting, the

implementation of comprehensive LDAR programs, and the modernization, replacement and optimization of infrastructure. In addition, the company reports on achieving a methane intensity of 0.32 % in its exploration and production (E&P) operations in 2024. For clarification, this methane intensity is calculated in line with the Oil and Gas Climate Initiative (OGCI) methodology, defined as the ratio of methane emissions from E&P oil and gas assets to the total gas sent to market.

In ROMGAZ's 2024 Consolidated Sustainability Statement (ROMGAZ, 2025) they disclosed gross Scope 1, 2, and 3 greenhouse gas emissions and discussed the methodologies, assumptions, and internal controls employed to ensure data integrity. While the reporting emphasizes overall GHG performance and sets targets for at least 10 % reductions in carbon, methane, and other gas emissions based on the 2021–2030 strategy, using 2020 as the baseline year, it does not provide specific methane emission numbers or trends.

Resources on methane emissions from coal exploitation in Romania

As part of the regional assessment of the country's methane emissions, we also briefly review Romania's coal mine methane (CMM) emissions, for which the following data sources are used.

The Global Energy Monitor (GEM) is a non-governmental organization that develops and maintains comprehensive, publicly available open datasets and trackers of energy infrastructure globally, including coal mines, power plants and oil and gas assets. Its mission is to improve transparency in the energy sector and support energy transition research, policy, and public accountability. GEM's Coal Mine Tracker ("Global Coal Mine Tracker", 2024) is this report's main source for infrastructure and operational data – namely, mine operator and mine-level coal production - on coal mines in Romania. GEM's Global Coal Mine Tracker additionally provides an independent dataset of coal mine methane (CMM) emissions based on their in-house calculations of CMM gas content using the Langmuir Isotherm Theoretical framework.

A few studies exist on coal mine methane emissions in Romania, with a focus on the Hunedoara Energy Complex in Transylvania, which consists of three operating underground coal mines and two which closed in the last five years. Coal seams in that area are particularly gassy and complex, and multiple accidents – at times fatal for the workers - have occurred in the past twenty years (Luca, 2018) The National Institute for Research and Development for Mining Safety and Anti-Explosive Protection – INSEMEX Petroşani has investigated methane emissions to the atmosphere as well degassing capability and efficiency for each of the mines of the Hunedoara Complex. This report exploits results from two INSEMEX studies from 2022 and 2024 (Chiuzan et al., 2022; Tomescu et al., 2024), which present measurement results from the years 2019 and 2022 on both emissions and recovered gas.

Our estimate for Romania's coal mine methane (CMM) emissions comes from the beta version of a new model developed by UNEP's IMEO. The model uses a statistical approach called Bayesian inference, which combines existing information (e.g., inventory data), known as prior, with new information (such as measurements) to produce an improved estimate of methane emissions from active metallurgical coal mines. In this model, the GEM coal mine emission factor is used as the prior information. The model then adds other available data, such as IPCC emission factors and any available empirical data, to update the estimate for each mine, known as posterior (van de Schoot et al., 2014). The final result is a central estimate, which is used as the mine's emission factor, along with a custom uncertainty range. This model aims to improve the accuracy of CMM emissions estimates through the integration of multiple data streams. Empirical data is treated as

the most reliable and therefore receives a higher weight than other estimates in the model. In-situ data from other mines that are considered sufficiently similar (for example, mines with comparable depth, location, or geological conditions) can also be included, but it will be given relatively low weight.

3. Regional methane emissions assessment

Before the assessment of regional emissions based on empirical data, we provide an overview of methane emissions from Romania's energy sector based on the national UNFCCC inventory for the period 2019 – 2023. Figure 3 presents this inventory data as a single stacked-bar panel in which each bar denotes the reported annual energy-sector methane total and is partitioned to show the relative contributions of coal, oil and natural gas. The UNFCCC category and subcategory definitions employed in this assessment are reported in Appendix Table A2.

Averaging across the 2019 – 2023 period, oil and natural gas together contribute roughly 30 % of reported energy-sector methane emissions, while coal accounts for the remaining ≈70 %, such that coal remains the dominant source in every reporting year (see Appendix Table A1 for the underlying sectoral shares).

Analysis of the UNFCCC time series indicates a modest but systematic decline in reported energy-sector methane emissions over the five-year interval: the total falls by approximately 8.4 % between 2019 and 2023. Sectoral trajectories are heterogeneous: the gas and oil sub-sectors exhibit the largest relative reductions (approximately −15 % and −13 %, respectively), whereas coal shows a smaller relative decline (approximately −6 %).

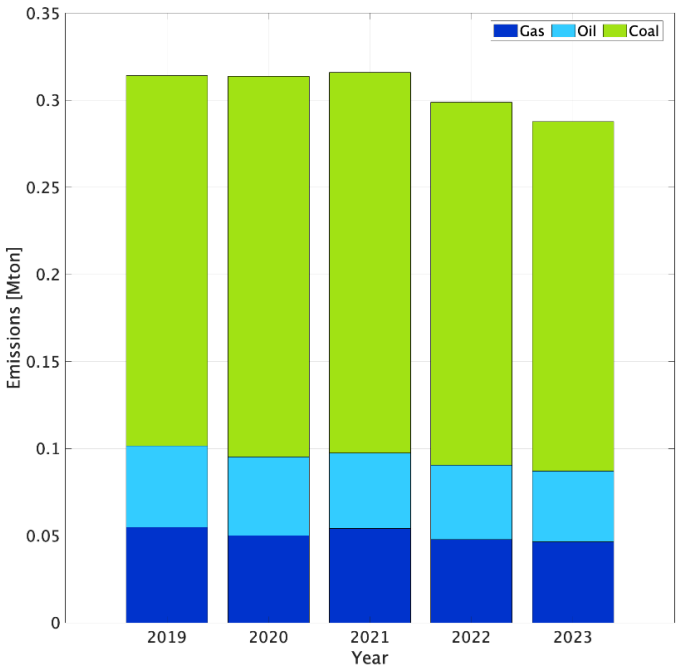

Figure 3: UNFCCC-reported methane emissions from Romania's energy sector (2019 – 2023). Stacked bars show annual total energy-sector methane (bar height) and the proportional contributions of coal (solid), oil and natural gas (coloured segments).

Overview of Romanian oil and gas supply chain and infrastructure

Romania's oil and gas supply chain is characterized by a combination of onshore and offshore production, extensive transmission networks, and a variety of processing facilities and natural gas distribution networks across cities. The country has over 400 known oil and gas fields and approximately 11,600 active onshore wells, according to information recorded in the Wells Fund. These are operated by a limited number of companies, with the most significant being OMV Petrom S.A. and S.N.G.N. Romgaz S.A. (*Upstream Solution*, 2025). Based on the National Energy Regulatory Authority (ANRE, 2025), together, these two companies account for over 87 % of national gas production as of January 2025. OMV Petrom accounts for almost the entire oil production in Romania and contributes roughly one-third of the country's natural gas production (OMV Petrom, 2025). Romgaz, by contrast, is Romania's leading natural gas producer. Table 1 provides a summary of the operations of OMV Petrom and Romgaz.

Table 1. Summary of operations from major oil and gas producer companies in Romania

	OMV Petrom	**Romgaz**
Production (2024)	40 mn barrel of oil equivalent (boe) (-3.5% vs 2023) • Crude oil: 19 mn bbl • Natural gas: 3.2 bcm	5 bcm natural gas (+4% vs 2023)
Share of national gas production	34 %	53 %
Infrastructure (2024)	149 commercial O&G fields ~6,000 – 7,500 active wells ~1,000 facilities ~8,000 km pipelines	>2,960 producing wells ~2,960 surface facilities and gathering pipelines 16 compressor stations (90 units) 21 booster + 22 cluster compressors

The transmission network is operated through the National Transmission System (SNT), managed by S.N.T.G.N. Transgaz S.A. and covers about 14,210 km of pipelines used for both domestic distribution and international transit (ROMGAZ, 2025). Underground gas storage is primarily managed by Depogaz, which controls 90.54% of the national underground capacity (ROMGAZ, 2025). Finally, the overall supply chain also includes a network of 27 distribution and supply companies that deliver gas to end users (ANRE, 2025).

Overview of the ROMEO campaigns and their results

The ROMEO campaigns were carried out in multiple phases over several months and years. The first campaign, conducted in October 2019, combined ground-based and airborne surveys with a focus on southern Romania, in close collaboration with the region's major operator, OMV Petrom. Measurements were fully independent from the operator, but the operators provided production and infrastructure data to plan the campaign. Eight ground measurement teams visited over 1,000 facilities, conducting site-level methane measurements at 337 oil and gas sites, with successful quantification at 282 sites. Emission distributions for oil production sites were derived

from 178 measurements, resulting in a representative methane emission factor of 5.4 kg/h per site [95% CI: 3.6 – 8.4] (Stavropoulou et al., 2023). The results also showed that methane emissions from oil production sites were highly skewed, with a small fraction of high-emitting sites driving the majority of emissions. Specifically, only 10 % of the sites were responsible for over 70 % of the total emissions. Other infrastructure types such as gas production sites, oil parks, and compressor stations were also measured and evaluated, but due to their smaller sample sizes, no detailed emission distributions were derived. Nevertheless, their average emissions provide useful indicators of potential emission factors: 31 gas production sites showed an average of 11.2 ± 4.0 kg/h, while processing facilities averaged 13.0 ± 3.0 kg/h (Kuhlmann et al., 2025; Stavropoulou et al., 2023). To complement the ground-based measurements, two research aircraft performed measurements at the regional scale to provide a top-down evaluation of methane emissions (Maazallahi et al., 2025). Analysis of the aircraft regional mass balance data across both small and large clusters of infrastructure resulted in an average emission factor of 5.3 ± 2.0 kg/h per site, based on the total number of active production sites and facilities in each cluster. This value closely matches the ground-based emission factor for oil production sites, 5.4 kg/h per site, providing an independent validation of the substantial emissions across the region.

In the source-level assessment, a total of 181 sites were inspected using the Optical Gas Imaging (OGI) camera, including 155 oil production sites. Emission sources were identified at over half of these sites, with more than 230 individual leaks detected. Due to restricted site access, emission rates could be measured for only 62 leaking components using the High Flow Sampler (HFS) method. These emission rates ranged from 0.07 kg/h per leak to 6.5 kg/h per leak. Analysis of the OGI videos showed that the most frequently detected sources were open-ended lines, which accounted for more than half (55 %) of the components detected. These vents appeared to be standard operational practices, underscoring the importance of the EU Methane Regulation's ban on routine venting. The remaining emission sources were attributed to malfunctioning equipment, such as flanges and threaded connections, accounting for approximately 20 % of detected emitting components, and to inaccessible or unknown components located below ground, which may include additional malfunctioning equipment or open-ended lines, accounting for around 25 % of identified leaking components.

The next phase of the ROMEO campaign was conducted in the Transylvanian Basin in July 2021 (Jagoda et al., 2025). This basin is the leading gas-producing region in the country, with no known oil reserves, which is why the campaign focused exclusively on gas production sites. In total, 160 emission rate estimates were obtained using five measurement techniques. Results are currently being finalised and will be published in an upcoming peer-reviewed study (Jagoda et al., in preparation).

The last phase of the ROMEO campaign took place also in 2021 across southern Romania, as in the first 2019 campaign (Kuhlmann et al., 2025). Opposite to the previous campaigns that relied on multiple measurement techniques, this time only one instrument was used, the Airborne Visible InfraRed Imaging Spectrometer – Next Generation (AVIRIS–NG). This advanced instrument is designed to rapidly detect and quantify CH_4 point sources while surveying large areas in a short timeframe. Within just two days, multiple flights were carried out, surveying 66 % of the known processing facilities (N≈580) and 82 % of the known oil and gas production sites in the region (N≈2800 and N≈300, respectively). The campaign was designed to both reassess emissions from the region after two years and to specifically detect and quantify high-emitting sources. The study found a decrease in super-emitters from oil production sites compared to the number expected based on the 2019 campaign, indicating a shift in the emission distribution. This

reduction corresponds to an estimated 20 – 60 % decrease in total emissions, likely reflecting mitigation measures or infrastructure improvements implemented after the 2019 findings. The study also identified several detected super-emitters as large vent stacks, representing a new source of emissions that was not evaluated in the previous campaign.

Country-level Emissions Estimate

For the present analysis, we leverage the empirical, measurement-based data obtained from the ROMEO campaigns to provide a country-level assessment of methane emissions from the oil and gas sector in Romania. As the most comprehensive set of empirical data comes from the 2019 campaign, this year serves as the baseline for our assessment.

We apply the previously reported emission factors for the respective facility types: oil production sites – 5.4 [3.6 – 8.4] kg/h, gas production sites – 11.2 [7.2 – 15.2] kg/h, and oil and gas facilities – 13.0 [10.0 – 16.0] kg/h. Country-level emissions are extrapolated using activity data derived from annual reports and publicly available information from OMV Petrom, since the ROMEO measurements were conducted at their facilities. Based on the annual report of the operator, for processing facilities we use a national activity estimate of 1,000 facilities. For oil and gas production sites, activity data stated in the report indicate approximately 7,500 operated active wells in 2024 including both types of infrastructure, whereas the company's website lists around 6,000 wells. We were unable to identify activity data reflecting total country-level operations for 2019. Considering that 193 commercial oil and gas fields were operated by OMV Petrom in 2019, compared to 149 fields in 2024, along with a reported decline in production over this period, the 7,500 wells can be viewed as a reasonable estimate. However, to maintain a conservative approach, we use the 6,000-well figure from the company's website, while acknowledging that it may potentially underestimate the total number of wells operating in 2019.

Additionally, since separate emission factors are applied to oil and gas wells, it is necessary to estimate the relative proportion of each well type within this total. However, no direct information on this distribution is available. Based on the evaluation from the ROMEO campaign, 90% of wells in the southern Romania study area were identified as oil wells, while 10% were gas wells (Kuhlmann et al., 2025). Although the ROMEO studies do not provide a comprehensive inventory of all wells in the country, this oil-to-gas ratio is used here as an approximate estimate**.** This ratio reflects only the composition of the specific regions surveyed during ROMEO and should therefore not be interpreted as comprehensive national statistics. In the absence of publicly available, country-wide well-type classifications, this regional ratio is used here strictly as an approximation for national scaling. Its use introduces uncertainty: if the actual share of oil wells nationwide were lower (or higher), the resulting national-level emissions would proportionally increase (or decrease), given that separate emission factors apply to each well type (higher for gas wells in Southern Romania). This assumption therefore represents a methodological gap that can be resolved only once Romania develops a complete, measurement-based well inventory under the EU-MER framework. Finally, consistent with the methodology applied by (Kuhlmann et al., 2025; Stavropoulou et al., 2023), we assume that a portion of facilities, specifically 25 % of the total sites in each category, do not emit methane, generating an even more conservative estimate of the overall emissions.

Based on the assumptions above, we estimate that part of Romania's oil and gas sector emitted a total of at least 320 kt [220 – 460] of methane in 2019. Of this, approximately 190 kt/yr [120 – 300] originated from oil production sites, 44 kt/yr [28 – 60] from gas production sites, and

85 kt/yr [66 – 105] from other oil and gas facilities. For comparison, Kuhlmann et al. (2025) report a total of ~220 kt [160 – 300], and Maazallahi et al. (2025) report ~230 kt [140 – 310] for 2019, both focusing only on the ROMEO study region in southern Romania. Our estimate is higher, as it covers operations across the entire country. Maazallahi et al. (2025), using an emission factor of 5.3 kg/h per infrastructure site to scale up nationally, estimated annual emissions of ~340 kt [210 – 470], falling within the uncertainty range of our estimate.

Building upon this baseline emission estimate for 2019, we extend our regional assessment of methane emissions to the year 2021, when the final phase of the ROMEO campaign took place and additional empirical data became available. According to the findings from Kuhlmann et al. (2025), oil and gas operations in southern Romania may have achieved a potential emission reduction of 20 – 60 % during the period 2019–2021. When applied to our 2019 estimate, this results in potential 2021 emissions of around 130 – 260 kt, with an average of 190 kt under a 40% reduction scenario. The national methane intensity[2] (loss rate) is estimated to range between 5% and 9%, depending on the assumed emission reduction scenario. Following the recommendations of (Seymour et al., 2025), we also include an energy-normalized methane intensity[3] to provide a fuller picture of emissions performance and to account for regions with mixed oil and gas production. The energy-normalized methane intensity for combined oil and gas production ranges from 0.89 to 1.78 kg CH_4 per GJ, on the higher end of the energy intensities of US and Canadian basins presented in Seymour et al, which range between 0.05 and 1 kg CH_4 per GJ produced.

For years after 2021, no new measurement campaigns have been performed to quantify and assess potential emission reductions. According to the 2025 National Inventory Report (NIR) submitted to the UNFCCC, which includes emission estimates up to 2023, reported emissions (category 1.B.2 Oil and Natural Gas and Other Emissions from Energy Production) decreased by approximately 10 % from 2021 to 2023, and by about 14 % from 2019 to 2023. Although UNFCCC-reported emissions do not represent actual reductions, since they rely on default emission factors and production data, this 10 % decrease from 2021 to 2023 can be used as a reasonable assumption for our analysis. Under this assumption, our measurement-informed estimate of total methane emissions for 2023 would range between 120 and 235 kt. However, the methane intensity remains roughly the same, since the decline in production offsets the emission reductions. Under the Tier 1 IPCC methodology applied in the UNFCCC Romanian inventory, emissions are directly proportional to activity levels (here production data), so variations in reported emissions over time merely reflect changes in production. The reported production data by major companies, illustrating this decline, are presented in Table A3 in the Appendix. All estimated emissions and their associated uncertainties for each emission reduction scenario are also presented in Table A3 in the Appendix.

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[2] The methane intensity (loss rate) is defined with the industry-approved OGCI definition, which is methane emissions as numerator and methane content of marketed natural gas as denominator. The calculation is based on natural gas production data from the main operator in southern Romania, as reported in their respective annual reports (see Table A3 in the Appendix), and assuming a natural gas methane content of 94% and a methane density of 0.67 kg/m^3.

[3] The energy-normalized methane intensity (kg CH_4/GJ) is defined as methane emissions as numerator and oil and gas energy production as denominator. The calculation is based on crude oil and natural gas production data from the main operator in southern Romania, as reported in their respective annual reports (see Table A3 in the Appendix), and using the conversion factors of 1 tonnes = 7.33 barrels of oil equivalent (boe), 1 boe = 6 gigajoules (GJ) and 1 bcm = 36 petajoules (PJ).

Discussion on coal mine methane (CMM) emissions in Romania

Coal mine methane emissions are generally reported using generic emission factors, expressed in kg methane emitted per metric ton of coal produced. The emission factors are drawn from the 2006 IPCC guidelines, which provide three tiers of emission factors that differ for underground and surface mines. In the IPCC guidelines, it is advised to choose a specific tier (from "low" to "high") based on the depth of the coal mine. This number does not account for regional variations in coal fields and is expected to have significant uncertainties. Romania's National Inventory Report (NIR) uses Tier 1 emission factors for mining emissions from underground and surface mining of 18 m^3/ton of coal and 1.2 m^3/ton of coal, respectively, corresponding to the medium default factors proposed in the IPCC guidelines for each mine type.

The main publicly available and comprehensive source of data on global coal mine emissions is the Global Energy Monitor's Coal Mine Tracker. To produce this dataset, the GEM makes use of a theoretical framework – their in-house M2CM model - relying on Langmuir isotherms to better estimate the gas content of coal mines as a function of depth. This model yields a continuum of estimates instead of discrete tiers and allows to derive a distribution of gas content by coal rank and mining depth. The GEM has yet to release a mine-level emissions data on abandoned coal mine methane emissions (AMM), and their 2024 report on AMM emissions in Europe does not consider mines with a closure year prior to 2015 – the vast majority of abandoned mines in Romania. An assessment of Romanian AMM emissions will therefore be left out of the present analysis.

The IEA estimates that in Romania, 8.2 kt of methane was emitted from active coal mining in 2023, mostly from steam coal exploitation (~7.9 kt). However, as previously mentioned, IEA's GMT reports country-specific coal-sector emissions only for a subset of major producers. For the remaining countries, emissions are estimated using a scaling factor. Since this number is neither precise nor granular, it is not included in the following discussion, whose focus is on mine-level emissions estimates.

Empirical studies from INSEMEX of specific mines in the Jiu Valley mining region, part of the Hunedoara Energy Complex, found net loss rates of approximately 12.8 and 11.4 kg methane/ton of coal produced in 2019 and 2022, respectively, corresponding to gross loss rates of 16.6 and 15.4 kg methane/ton of coal. This indicates a gas capture efficiency of about 34 - 37 % in active mines from the Hunedoara Energy Complex. Neither the GEM nor the IPCC values account for potential mitigation, and their estimates therefore correspond to gross emissions. They are both lower (substantially, for the GEM numbers) than the gross emissions measured in these studies. Furthermore, the 2023 NIR only reported ~0.13 Mt of coal produced from underground coal mining in 2023, all from abandoned mines, which is refuted by a March 2024 Radio Romania article which cites a daily production of ~800 tons of coal per day (totaling to approximately 0.29 Mt of coal produced in 2023), all from mines located in the Jiu Valley and part of the Hunedoara Energy Complex (*Complexul Energetic Valea*, 2025). This further highlights the need to consider empirical and independent data sources to avoid the underreporting of emissions.

For that purpose, a Bayesian inference framework is used to integrate, at the mine level, estimates for mining emissions in active coal mines in Romania, with the further consideration of the INSEMEX in-situ studies to estimate emissions from underground coal exploitation in the Hunedoara Energy Complex in Northeast Romania. For all surface mines in Romania, the GEM is used as a prior and the IPCC number as a single bottom-up datapoint to derive a posterior

emission factor. Figure 4 (and Table A4 in the Appendix) shows a mine-by-mine comparison of the three estimates.

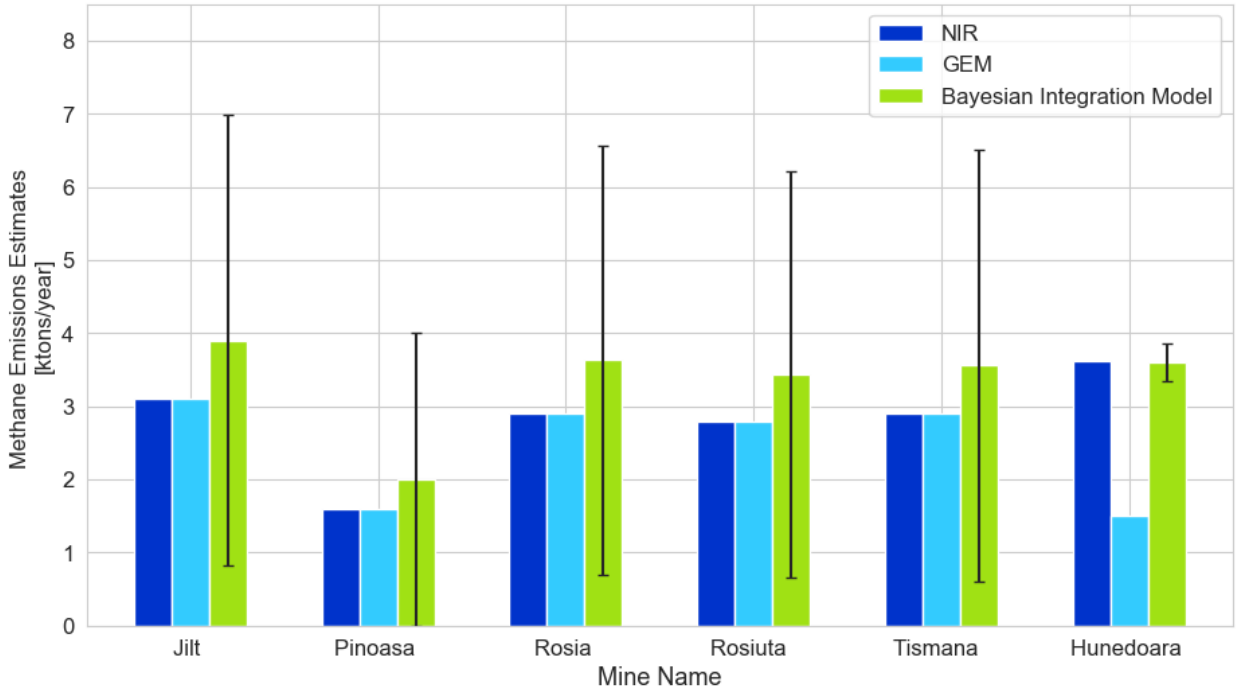

Figure 4. Comparison of emissions for Romanian coal mines.

Our results lead to a central estimate from active coal mining activities in Romania of approximately 21.3 ± 6.2 kt/y (adding post-mining activities to our mining estimate) corresponding to an uncertainty range [15.1 - 27.5] kt/y.

4. Discussion and conclusions

This report provides a regional assessment of methane emissions from Romania's oil and gas sector, based on empirical, measurement-based data from the ROMEO campaigns. Using 2019 as a baseline, the year with the most comprehensive dataset, and applying previously reported emission factors for the onshore upstream sector, we estimate that Romania's oil and gas sector emitted at least 320 kt of methane [220 – 460] in 2019. Extending the analysis to 2021, the final phase of the ROMEO campaign indicates potential emission reductions of 20 – 60 % in some regions, resulting in estimated national emissions of 130 – 260 kt methane. For 2022–2023, although no new measurement campaigns have been conducted, UNFCCC-reported emissions suggest an additional ~10 % decrease from 2021, resulting in an estimated range of 120 – 235 kt methane emissions for 2023, and mainly explained by a slight decrease in production. In the aggregate, these estimates translate to a methane intensity of 5 – 9% (loss rate) and 0.89 – 1.78 kg CH_4/GJ (energy basis).

Comparison with official emissions reporting

When comparing our national emission estimates with the national inventory, we find a substantial underestimation of methane emissions, consistent with the ROMEO studies and with findings from studies in other countries (Maazallahi et al., 2025; MacKay et al., 2021; Riddick & Mauzerall, 2023; Stavropoulou et al., 2023; Tibrewal et al., 2024). Figure 5 compares methane emission estimates from this analysis with those reported to the UNFCCC for 2019, 2021, and 2023. Our estimates are approximately two to three times higher than the corresponding UNFCCC values, with the largest discrepancy observed in 2019. It is important to note that our estimates do not even account for emissions from the entire oil and gas sector included in the national inventory, which also includes the processing, storage, transport and distribution of oil and gas. As previously highlighted in the ROMEO studies, this discrepancy arises from the national inventory's reliance on the Tier 1 IPCC methodology, which applies generic emission factors and production data that fail to capture country-specific operations and the actual magnitude of emissions. This underestimation of emissions, resulting from a non-country-specific evaluation, is also evident in the comparison with the IEA emission estimates. For 2021, the IEA estimates emissions from onshore oil and gas at 59 kt – approximately 3 – 5 times lower than our estimate. In contrast, in 2023, emissions from the same sector rise to 142 kt, aligning more closely with our findings and suggesting a possible readjustment of emission figures following insights from the ROMEO studies.

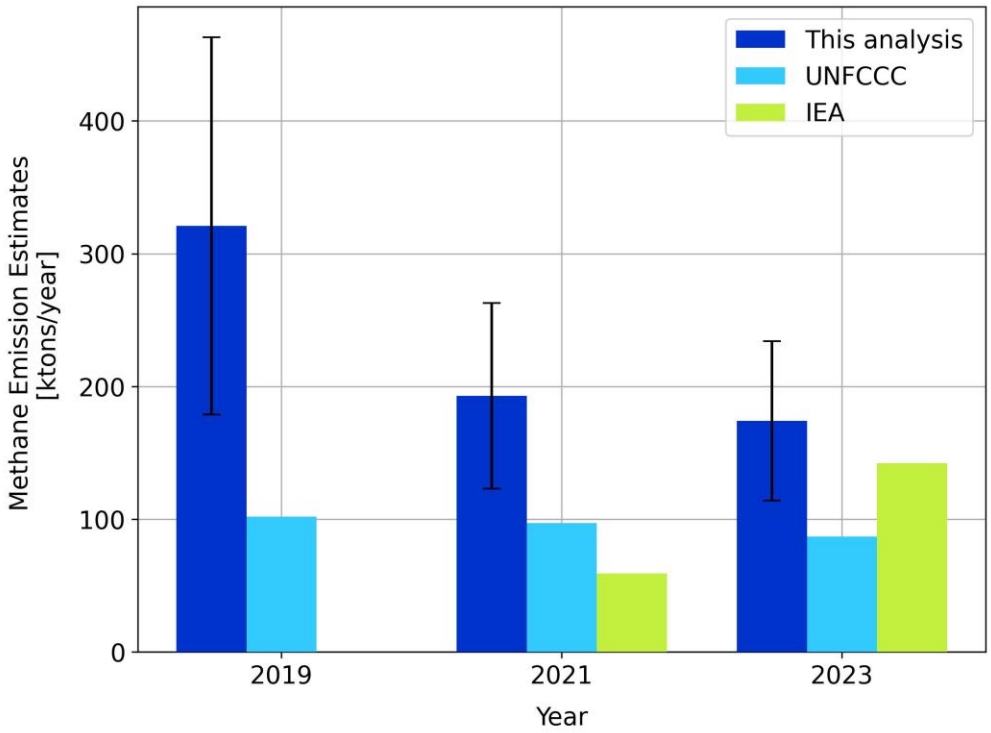

Figure 5. Comparison of methane emission estimates from this analysis (blue) and UNFCCC-reported emissions (light blue) for 2019, 2021, and 2023. For 2021 and 2023, estimates correspond to the 40% emission reduction scenario relative to 2019 levels. UNFCCC reported emissions include total methane emissions from category 1.B.2 — Oil and Natural Gas and Other Emissions from Energy Production. IEA estimates (green) include methane emissions from the categories *onshore oil*, *onshore gas* and *other from oil and gas*.

A similar underestimation is observed when our estimates are compared with the emissions reported in the companies' environmental performance reports. According to OMV Petrom's annual reports, methane emissions were reduced by half in 2020 compared to 2019, and methane intensity decreased by a total of 80 % in 2024 compared to 2019. Specifically, in 2019 total emissions were estimated at 40 kt, corresponding to an Exploration and Production (E&P) methane intensity of 1.6 %, while by 2024 total emissions had decreased to 6 kt, corresponding to an E&P methane intensity of 0.32 %. Although the ROMEO campaign results suggest that a 60 % emission reduction between 2019 and 2021 is possible and an 80 % reduction between 2019 and 2024 is therefore plausible, the actual emissions and baseline values in both our analysis and the ROMEO studies differ substantially from the company's reported figures. This can be explained by the fact that the company's reported emissions are not based on direct measurements. As noted in the company's reports, Scope 1 GHG emissions are calculated by multiplying activity data with emission factors from sources such as the IPCC and API GHG Compendium. These emission factors are generic and do not account for the specific infrastructure or operational conditions of the company or the country. Therefore, the reported figures likely underestimate the actual magnitude of emissions, similar to the inventory-based estimates.

Approximately 50 % of natural gas production in Romania in 2023 was produced in assets operated and owned by Romgaz, which is a member of UNEP's IMEO Oil and Gas Methane Partnership 2.0 (OGMP2.0) since 2023. In the 2024 OGMP2.0 reporting round, Romgaz reported 9.6 kt of methane emissions for 2023, with most of the emissions being reported at Level 3. Level 3 requires that emissions are reported by detailed source type but is based on generic emissions

factors. In the 2025 OGMP 2.0 reporting round, Romgaz's methane emissions for 2024 remained the same as in 2023, showing no progress in their reporting. Consequently, the company lost its Gold Standard Pathway and is no longer on track to achieve the Gold Standard by 2026. In general, as companies progress to higher OGMP 2.0 reporting levels – the highest level achieved within three years for operated assets –, their emissions estimates become increasingly accurate, as they are based on direct measurement data rather than generic emission factors. Future OGMP 2.0 reporting rounds, together with the EU-MER MRV requirements, are expected to provide more reliable emissions data, providing a clearer understanding of actual methane emissions.

Data gaps and uncertainties

Assessing methane emissions at the country level is challenging due to significant data gaps and uncertainties. Information on infrastructure elements is often scarce, incomplete, or entirely unavailable across the years. While previous efforts have attempted to create comprehensive databases of oil, gas, and coal infrastructure, the lack of publicly available geospatial data limits their usefulness. For example, the Oil and Gas Infrastructure Mapping (OGIM) developed by the Environmental Defense Fund (EDF) and MethaneSAT LLC provides highly detailed data for some countries, mostly in North America, but offers limited information for countries such as Romania. Although specific geospatial data were not required for our current analysis, they can be critical when combined with other types of measurement-based data such as satellite observations, However, no satellite datasets were integrated here, as validated MethaneSAT products were not yet available at the time of writing, and other satellite systems commonly exploited for methane monitoring (e.g., GHGSat, TROPOMI, Carbon Mapper) currently lack the resolution, coverage, or quantification accuracy needed for robust country-level estimates. In our case, while some geospatial data such as the total number of facilities for major operators, covering the majority of production, were partially available, we still had to make assumptions about the number of facilities of each type, such as oil versus gas wells. These assumptions introduce uncertainty and could lead to over- or underestimation of emissions.

Detailed measurement-based data are also lacking. Although several measurement campaigns have been performed in Romania, providing a relatively comprehensive and representative dataset from the most important segments and regions of its oil and gas industry, gaps in emissions data remain. Specifically, our estimates do not cover all regions and segments. While the 2021 estimate is the most comprehensive to date, covering a significant fraction of the country's oil and gas production, certain components, such as smaller operators, smaller producing regions, the offshore sector, the downstream segment, and inactive or abandoned wells, were excluded. This exclusion may result in an underestimation of emissions. However, previous studies indicate that the bulk of emissions typically originates from the upstream segment in most production regions (Alvarez et al., 2018; *Global Methane Tracker*, 2025; Scarpelli et al., 2022). Consequently, our estimates are expected to provide a reasonable overall indication of emission magnitude, although the combined contribution of the excluded sources should not be entirely neglected. Similarly, there are no empirical data available on emissions from Romania's coal sector.

In accordance with the EU-MER, Romania is required to compile and publish a comprehensive inventory of inactive, temporarily closed, permanently closed, and abandoned wells. Based on the most recent data published by the National Regulatory Authority for Mining, Petroleum and Geological Storage of Carbon Dioxide (ANRMPSG), the total number of wells covered by the regulation is estimated at approximately 47,390 (*Inventar sonde (ue) 2024/1787*, 2025). This

figure will be periodically updated as the inventory development process progresses. In the first inventory published to meet the EU-MER's August 5, 2025 deadline, at least 20 % of all wells, representing a total of 10,618 wells, were included, with the goal of achieving full coverage (100 %) by 2030.

As mentioned previously, our assessment does not include emissions from inactive, temporarily closed, permanently closed, or abandoned wells. However, their potential significance should not be underestimated, particularly given the large number of such wells. Previous studies in the U.S. and Canada have demonstrated that abandoned and inactive wells can represent a non-negligible source of methane emissions, in some cases contributing significantly to oil and gas methane emissions. Field measurements have revealed highly variable emission rates, with a small fraction of wells responsible for the majority of observed methane fluxes (Kang et al., 2014; Williams et al., 2021). These findings suggest that, where legacy well infrastructure is extensive—as in parts of Romania—further investigation of this source could improve the completeness of the national methane inventory. In Romania, the IEA estimates that abandoned facilities contribute a total of 52 kt to overall methane emissions, roughly 20 – 30 % of our estimated 2023 emissions from active wells (*Global Methane Tracker 2025 – Analysis*, 2025). Since no measurements have yet been performed for this category of infrastructure, a measurement campaign assessing methane emissions from inactive wells is currently underway as part of the UNEP-funded project Global Analysis of Methane Emissions from Abandoned Oil and Gas Wells. The results of this study are expected to provide a clearer understanding of the actual emissions associated with the large number of abandoned wells in Romania.

We also briefly discuss emissions from the coal sector and integrate multiple data sources to establish an independent estimate for active coal mining emissions in Romania. This estimate is 40% higher than the emissions from active coal mining reported in the country's 2023 NIR and double the IEA's 2023 Global Methane Tracker estimate for Romania's methane emissions from coal exploitation. Nonetheless, emissions from abandoned underground coal mines in Romania remain an essential topic that we have not discussed here due to the lack of independent data. Romania's reported emissions from active coal mining are significant– AMM emissions are the main contributor to Romania's reported fugitive emissions from the energy sector. Nonetheless, this reported data is entirely based on generic emission factors and could equally be higher or lower than actual AMM emissions in Romania. It is essential that such emissions are accurately quantified and, to the extent possible, captured and reutilized – which will be mandated by the EU Methane Regulation from 2030 onwards.

5. Policy and economic perspective

Independent, measurement-based data are fundamental for establishing accurate emissions baselines and national reporting for Romania's oil and gas sector. As discussed earlier in the report, current methane inventories, which rely primarily on activity data and generic, non-country-specific emission factors, underestimate actual emissions and are subject to significant uncertainty. Consequently, current estimates likely underestimate actual emissions, leading to misinformed conclusions on both mitigation potential and progress. Incorporating empirically derived data from multi-scale measurements enables more accurate quantification of emissions and the identification of emitting facilities and operational practices. Without updated, observation-based data, Romania's methane baseline remains uncertain, weakening the analytical foundation for setting realistic reduction targets or evaluating the effectiveness of mitigation policies.

The availability - or absence - of up-to-date independent data has direct implications for verification of reported emissions. Under the EU-MER, operators must provide verified, measurement-based reporting. The use of available measurement-based emission datasets will allow Romania's Competent Authorities (CAs) to cross-check operator-reported data and identify inconsistencies. This will not only enhance compliance under the EU-MER framework but also strengthen the accuracy and credibility of Romania's national inventory under the UNFCCC.

The Regulation creates an opportunity to align national reporting with EU-wide standards and to build capacity to ensure alignment between operator reporting, EU MRV requirements, and national GHG inventory submissions under the UNFCCC. For the successful implementation of the EU-MER, standardized protocols for MRV are needed, following either international standards or those derived under the EU-MER. For the verification process to be effective, Competent Authorities need to have a structured framework for data collection and comparison. Aligning measured and reported data requires transparent methodologies and open data exchange between regulators, operators, and independent researchers.

From an industry perspective, EU-MER's regulatory environment represents both a challenge and an opportunity. To comply effectively, companies need to strengthen their MRV capacity. Investments in robust MRV systems not only ensure regulatory compliance but also deliver operational efficiencies through early leak detection and repair, product recovery, and stronger environmental performance. Collaborative initiatives between CAs, operators, and research institutions can accelerate the deployment of measurement technologies, the adoption of international best practices and the harmonization of measurement protocols across Romania's oil and gas assets.

Methane abatement offers one of the most cost-effective pathways for near-term climate mitigation. According to the International Energy Agency's Global Methane Tracker 2025, more than 75 % of oil and gas methane emissions can be technically abated with existing technologies, and roughly 40 % can be eliminated at no net cost, primarily because captured gas has commercial value. The GMT's evaluates these abatement potentials at more than 70% and 45% for Romania. Typical low-cost measures include replacement of open-ended lines, reduction of venting and flaring, improved maintenance of pneumatic devices, and optimized leak detection and repair (LDAR) programs.

For Romania, there may be substantial economic benefits beyond emission reductions. Capturing and marketing gas that would otherwise be emitted or flared can generate additional revenue, offset abatement costs, and strengthen energy security by increasing domestic supply. Furthermore, demonstrating verifiable, measurement-based emission reductions can position Romania competitively in European energy markets, where methane performance is increasingly linked to trade and investment decisions.

Measurement-based data generated through campaigns like the ROMEO and upcoming projects, provide a foundation for a measurement-based, independent economic analysis of methane abatement. By quantifying emissions at the asset level, policymakers and investors can identify where interventions yield the highest return on investment. This evidence can also inform national mitigation strategies. However, the robustness of any such analysis depends critically on the regular availability of updated empirical data. Without frequent measurement updates, cost-benefit estimates rely on outdated assumptions and introduce uncertainty into both national policy and industry planning.

Methane from coal mining remains a significant but often under-monitored source of emissions. While Romania reports Coal Mine Methane (CMM) emissions from both surface and underground mines, these estimates rely on generic emission factors, and direct measurement data remain scarce. Evidence from Central Europe underscores the need to address this data gap.

Equally important are emissions from abandoned coal mines, known as Abandoned Mine Methane (AMM). Romania's National Inventory Report (NIR) lists a large number of closed or abandoned sites, but the magnitude of post-closure methane release remains poorly constrained. Experience shows that systematic AMM monitoring and gas capture that is utilized for power generation or district heating programs can mitigate most of these emissions. Adopting similar approaches in Romania could provide both environmental and economic benefits.

Capturing CMM or AMM gas has commercial value and represents a substantial resource if harnessed effectively. For Romania, monetizing captured gas could offset mitigation costs, contribute to local energy security, and create opportunities for regional redevelopment in former mining areas.

6. Outlook

The coming years are expected to bring significant improvements in the accuracy and granularity of methane emissions data in the energy sector. The implementation of the EU-MER will establish a new data ecosystem, driven by mandatory measurement, reporting, and verification (MRV) requirements for oil, gas, and coal operators. These data flows will provide a more reliable, measurement-based foundation for national inventories and targeted mitigation strategies.

Ongoing and planned research initiatives such as the campaign as part of the IM4CA project and SMART-CH4 project from European Space Agency (ESA) are anticipated to further enhance empirical understanding of methane emissions. These projects will deploy multi-scale measurement approaches (satellite, aerial, and ground-based observations), delivering independent datasets that can help validate operator-reported information, identify emission hotspots, and assess the effectiveness of mitigation measures. The integration of these independent observation systems into Romania's reporting and policy framework will represent a critical step toward robust and transparent methane accounting.

This report will be updated in Q3 2026, following the first full year of data reporting under the EU-MER and the availability of preliminary findings from other data driven projects and initiatives. As part of the update, we will integrate new available measurement-based datasets and reassess national and sectoral methane emission estimates considering improved data accuracy (Jagoda et al., 2025). Potential additional data sources include preliminary results from initiatives such as IM4CA and the UNEP-funded Global Analysis of Methane Emissions from Abandoned Oil and Gas Wells, should relevant datasets be available by the time of the next update. Further improvements may also come from Romanian operator reporting under OGMP 2.0, together with the EU-MER MRV requirements, as companies progress through higher accuracy tiers and provide more robust, measurement-based data. However, delays in publishing the first company reports under EU-MER (originally expected in November 2025), as well as setbacks in companies' progress along the OGMP 2.0 pathway toward measurement-based reporting levels, have already occurred, creating uncertainty around the availability of this data. Finally, although the unexpected loss of MethaneSAT in June 2025 removed one of the originally anticipated measurement sources, there remains the possibility that unprocessed or partially processed MethaneSAT data collected prior to the loss will become available and may be integrated into the updated assessment. If available in time, these data will complement the first report and provide a more robust resource to support the implementation of the EU-MER by policymakers, regulators, and other stakeholders. In addition to MethaneSAT, other satellite systems such as Carbon Mapper, GHGSat, TROPOMI, and Copernicus missions may also provide supplementary information in future updates. While these platforms are valuable for detecting large individual plumes or for observing coarse regional methane patterns, their current spatial resolution, revisit frequency, and quantification capabilities are not yet sufficient to support consistent, country-level methane estimates for Romania. As these datasets and retrieval algorithms continue to evolve, we will evaluate their suitability for integration into the next edition of this assessment.

Strengthening methane mitigation in Romania's energy sector will require continued collaboration among industry operators, research institutions, and national agencies. Priority areas may include improving data harmonization and transparency between operator-reported and independently measured emissions; building technical capacity for advanced monitoring, reporting, and verification (MRV); promoting deployment of detection, measurement and

quantification technologies; and strengthening stakeholder collaboration so that empirical findings directly inform national inventory improvements.

Appendix

Table A1. Emission data Summary (2019-2023)

Year	UNFCCC [kt]			
Sector	Gas	Oil	Coal	Total
2019	55	47	213	315
2020	50	45	219	314
2021	54	44	219	317
2022	48	43	208	299
2023	46	41	201	288

Table A2. UNFCCC categories and subcategories for methane emissions from coal, oil, and natural gas exploitation.

Fuel type	UNFCCC code	Category description
Coal	1B1a	Coal mining and handling
	- 1B1ai	Underground mines
	- 1B1ai1	Mining
	- 1B1ai2	Post-mining activities
	- 1B1ai3	Abandoned underground mines
	- 1B1aii	Surface mines
	- 1B1aii1	Mining
	- 1B1aii2	Post-mining activities
Oil	1B2a	Oil
	- 1B2ai	Exploration
	- 1B2aii	Production
	- 1B2aiii	Transport
	- 1B2aiv	Refining
	- 1B2av	Distribution
	- 1B2ci1	Venting
	- 1b2cii1	Flaring
Gas	1B2b	Natural Gas
	- 1B2bi	Exploration
	- 1B2bii	Production
	- 1B2biii	Processing
	- 1B2aiv	Transmission and Storage
	- 1B2av	Distribution

	- 1B2ci2	Venting
	- 1b2cii2	Flaring

Table A3. Estimated emissions from our analysis and reported natural gas production for years 2019, 2021 and 2023.

		2019	2021			2023		
Emissions reduction scenario (relative to the baseline)		0 % (Baseline year)	20 %	40 %	60 %	30 %	50 %	70 %
Annual emissions and uncertainties (ktons)		320 [220 – 460]	260 [180 – 370]	190 [130 – 280]	130 [90 – 180]	235 [160 – 330]	170 [120 – 250]	120 [80 – 160]
Natural gas production [bcm]	OMV Petrom	4.4	3.7			3.3		
	Romgaz	5.3	5.0			4.8		
	Total country*	9.9	8.9			9.2		
Crude oil and NGL production [mn tonnes]	OMV Petrom	3.3	3.1			2.8		
	Total country*	3.6	3.3			3.0		

*Source of data: Eurostat (*Statistics | Eurostat*, n.d.)

Table A4. Comparison of methane emissions estimates from Romanian coal mines based on NIR Tier 1 values, GEM data, and the Bayesian model (2020–2023)

Mine	Coal Production	Prod Year	2023 NIR Tier 1 values		GEM		Bayesian model		
	(Mt/Year)		Loss rate (kg/ton)	Total emissions (kt/y)	Loss rate (kg/ton)	Total emissions (kt/y)	Loss rate (kg/ton)	Total emissions (kt/y)	Std dev fractional
Jilt Coal Mines	3.9	2020	0.8	3.1	0.8	3.1	1	3.9	0.79
Pinoasa Coal mine	2	2021	0.8	1.6	0.8	1.6	1	2	1
Rosia Coal Mine	3.6	2021	0.8	2.9	0.8	2.9	1	3.6	0.81
Rosiuta Coal Mine	3.4	2021	0.8	2.8	0.8	2.8	1	3.4	0.81
Tismana Coal Mine	3.6	2021	0.8	2.9	0.8	2.9	1	3.6	0.83

Hunedoara Energy Complex	0.3	2023	12	3.6	4.83	1.5	12	3.6	0.071
Total (active coal mines)	13*		NA	17	NA	15	NA	NA	NA

**This total combines both 2021 and 2023 production values, while the Romanian 2023 NIR reports 14.6 Mt of coal produced from surface mining.*

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