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METHANE EMISSIONS IN CZECHIA'S ENERGY SECTOR

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

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Abbreviations

AMM	Abandoned Mine Methane
CA	Competent Authority
CH_4	Methane
CMM	Coal Mine Methane
EEA	European Environment Agency
EUKI	European Climate Initiative
EU-MER	European Union Methane Emissions Regulation
GCMT	Global Coal Mine Tracker
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
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention for Climate Change
AMM	Abandoned Mine Methane
CA	Competent Authority
CCAC	Climate and Clean Air Coalition
CH_4	Methane

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Executive summary

Overview

Methane (CH_4) is a potent greenhouse gas, with a global warming potential 84 times greater than CO_2 over a 20-year horizon and 29.8 times greater over a 100-year horizon *(Methane Emissions - European Commission, 2025)*. In Czechia, 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 coal sector and briefly discusses the oil and gas sector. The assessment builds upon the results of global research efforts on methane emissions from the energy sector, providing insights to support Czechia's implementation of the EU Methane Emissions Regulation (EU-MER) and the continuous improvement of national inventories under the UNFCCC framework (Eur-Lex, 2025).

Key findings

Regional methane emissions from Czechia.

- The integration of various data streams through an advanced statistical model based on Bayesian inference leads to an independent estimate of 69 kt of methane emissions from the coal sector in Czechia.

Results suggest that actual emissions from coal operations in Czechia are likely to be significantly higher than official estimates.

- The analysis shows that official UNFCCC-reported emissions are two to three times lower than the estimate from the present study.
- This discrepancy arises notably from the latest NIR's extrapolation of the emission factor for a single surface mine to all surface mines in the country, the use of company reported data, which was not independently verified, and from varying assumptions on gas recapture rate in Czech legacy mines.

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

Methane emissions from the extraction, processing, transportation and storage of oil and gas remain poorly quantified in Czechia, with current estimates based solely on generic emission factors, introducing high uncertainty. 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 Emissions Regulation (EU-MER) (*Eur-Lex*, 2025). 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 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 scale. Particularly, this report aims to provide an assessment of methane emissions from the energy sector in the Czech Republic based on several independent data sources, integrating empirical, measurement-based data when available.

EU Methane Emissions Regulation

The EU Methane Regulation (EU-MER) entered into force in August 2024 and is the first 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 violations). 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 coal sector, Article 20 of the EU-MER sets out requirements for monitoring and reporting emissions from active underground and surface coal mines. Particularly, underground coal mines are required to implement continuous and direct measurements and quantification of methane emissions from all drainage stations and ventilation shafts. Furthermore, the EU-MER sets out specifications for mitigation of methane emissions resulting from active underground coal mines, including the reporting of venting and flaring

events. Monitoring, reporting and mitigation from closed and abandoned underground coal mines is also required, and venting from those mines is strictly prohibited. For closed and abandoned mines, requirements on source-level direct measurements in accordance with the applicable standards are also included. The regulation sets out transparency requirements, mandating that competent authorities 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.

Regional methane context

The European Environment Agency (EEA), based on data reported by EU Member States under the EU Governance Regulation (*EEA Greenhouse Gases — Data Viewer*, 2025), which reflects the greenhouse gas inventory as reported under the United Nations Framework Convention for Climate Change (UNFCCC), estimated that in Czechia, for 2023, waste accounted for 46.5 % of total methane emissions, followed by agriculture at 35.2 %, and energy at 9.4 % (see Figure 1 for the sectoral shares). Methane reporting to the UNFCCC relies mainly on activity data combined with default emission factors. Only a few categories use Czech-Republic-specific values, and most emission factors remain non-country-specific rather than based on direct measurements.

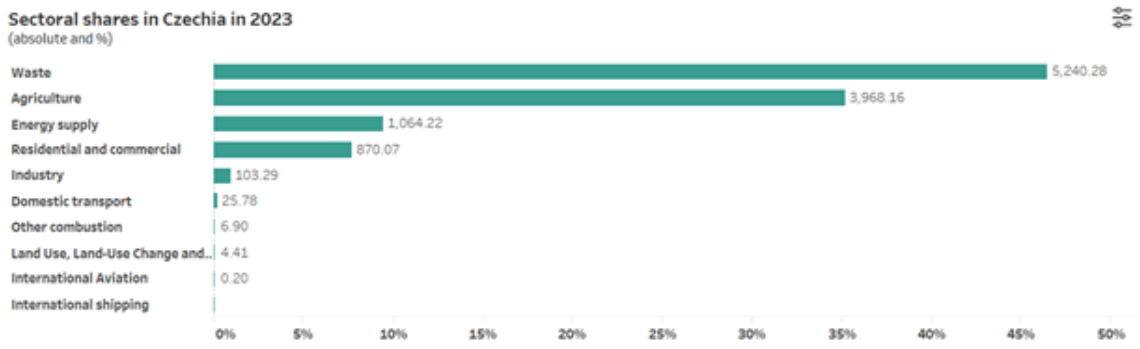

Figure 1. Methane emissions in kt CO_2eq from all sectors in 2023 in Czechia. Source: European Environment Agency based on the country reporting to UNFCCC.

Czechia is the third largest coal producer in the EU after Poland and Germany. According to data reported to the UNFCCC, in Czechia around 60% of fugitive emissions from fuels come from solid fuels (e.g., coal) and 40% from oil and gas. Although the waste and agriculture sectors account for the largest share of reported methane emissions in Czechia, the energy sector remains a critical focus for targeted analysis and mitigation. Methane emissions from oil, gas and coal operations are typically characterized by high uncertainty but also by significant and cost-effective mitigation potential. Unlike diffuse sources like those from the agricultural and waste sector, emissions from fossil fuel extraction originate from identifiable equipment and processes where technology already exists to mitigate those emissions and achieve reductions. Measurement-based approaches, including those proposed in the EU-MER, provide a strong foundation for improving data accuracy

that allows implementing effective abatement solutions that have the highest potential to reduce emissions.

The independent assessment of Czechia regional methane emissions in this report serves as a baseline for Czechia's methane emissions, 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 best-available 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 and methods used to assess methane emissions from the coal, oil, and gas sectors. Section 3 presents a detailed assessment of Czech coal mine emissions, including active and abandoned mines. Section 4 discusses key results and uncertainties, and comparisons with official inventories, while section 5 concludes with policy and economic implications. Finally, Section 6 provides an outlook and summary of the 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 regional emissions presented in Sect. 3. These data sources include inventories, science studies and operator 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.

The 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 Czechia to the UNFCCC, the 2025 National Inventory Document 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.

Reports on the Operation of the Czech Gas System, compiled yearly by the Energy Regulatory Office of the Czech Republic are used throughout this report for detailed data on gas production, supply and infrastructure, such as length of distribution and transmission pipelines. Another valuable resource on infrastructure data from the midstream and transmission segment is the NET4GAS website, which lists compressor and border transfer stations across the country.

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 of the yearly compilation of a Global Methane Tracker (GMT), estimating global methane emissions from the Energy Sector. The GMT does not have a comprehensive country-level coverage and aggregates data for smaller European countries, including for the Czech Republic, and is therefore not a data source on methane emissions for the present analysis. However, we use other IEA datapoints on production and energy use in this report.

Rystad Energy is an independent energy research and business intelligence company that provides comprehensive data and analytical tools covering the global oil and gas sector. Its databases integrate asset-level information on production volumes and infrastructure across operators, derived from both proprietary models and public sources. Rystad data supports the spatial and temporal analysis of emissions particularly from the upstream sector. This report mainly draws on Rystad's Upstream Solution for field-level oil and gas production and operational data.

Data on methane emissions from the oil and gas sector in the Czech Republic is very scarce, with most estimates available based on generic emission factors, found in the UNFCCC inventory reports and its gridded counterparts (e.g., GFEI (*GFEI V3*, 2025)) and

EDGAR (Crippa et al., 2025)). No science studies could be found as reference for this report on oil and gas methane emissions estimates that are based on measurements performed in the Czech Republic.

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. The 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 Czechia. There exists limited data on coal mine emissions outside official inventories. The GEM's Global Coal Mine Tracker, however, 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.

Very few in-situ studies are available on methane emissions from the coal sector in Czechia. The study by Buzek et al. (Buzek et al., 2022) was conducted at the Bilina surface mine in the Northern Bohemian basin. It combined direct gas measurements from coal samples with isotopic mass-balance calculations to produce two separate estimates of methane release: one based on the isotopic composition, and the other derived from direct measurements of desorbed gases. Results from this study are discussed in more detail in section 3 of this report.

Hudeček et al., 2011, is a study by the Faculty of Mining and Engineering of the Ostrava Technical University, which does not directly cover methane emissions from coal mining, but instead takes an interest in degasification technologies and their efficiency for abandoned underground mines of the Ostrava-Karvina Coal (OKC) Basin. This study presents helpful numbers, and in particular volumes of recovered gas in Ostrava-Karvina mines between the years 1958 and 2009.

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 a relatively low weight.

The diversity of datasets used as references in this report poses several challenges, particularly when aiming to compare consistent temporal data. Different datasets can correspond to different reference years, yet the limited availability of independent data

sources sometimes required comparing estimates across years. This adds another layer of uncertainty, as methane emissions can vary considerably from year to year. We nevertheless sought to ensure that such temporal gaps did not exceed one to two years throughout our analysis, or that neither production trends nor operator practices significantly changed and impacted emissions during that time.

The lack of quantified uncertainties in the reference datasets is also a challenge. The GEM does not include uncertainties in their estimate of coal mine methane emissions, while the IPCC advises to use a generic "factor of 2 greater or smaller" than the value of the emission factor. The Bayesian approach used in this analysis is a significant improvement on that account, as it aims to produce a central estimate along with a standard deviation whose value depends, among other things, on the number and type (e.g. empirical or emission factors) of input data points.

3. Regional methane emissions assessment

Before the assessment of regional emissions based on empirical data, we provide an overview of methane emissions from Czechia'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 decreasing trend in energy-sector methane over the five-year interval. In Figure 2, two values are shown for the coal sector: the one reported in the 2022 NIR (dark green) and the updated estimate from the 2023 NIR (light green). This comparison highlights the sharp decrease in estimated coal mining emissions introduced with the revision of the emission factor for surface mining between the 2022 and 2023 reporting years. The revised factor accounts for most of the apparent reduction and will be discussed in further detail in the following section. For other subsectors, the methodology remained consistent over the years.

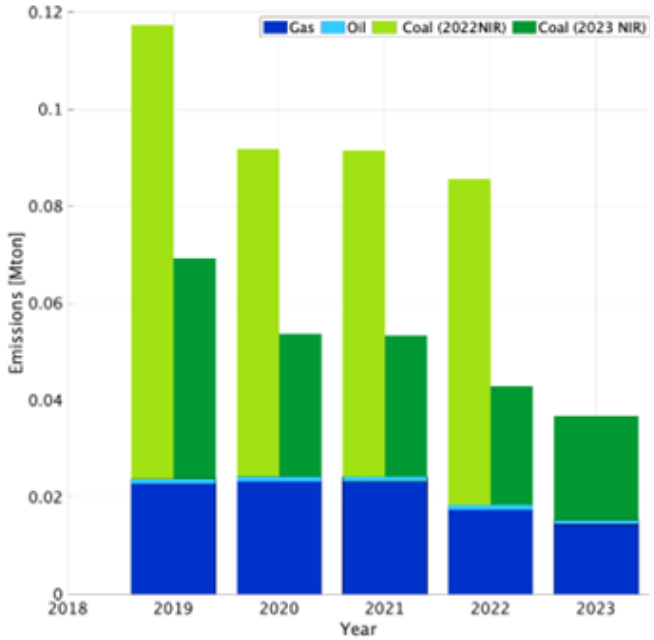

Figure 2: UNFCCC-reported methane emissions from Czechia's energy sector (2019 – 2023). Stacked bars show annual total energy-sector methane (bar height) and the proportional contributions of coal, oil and natural gas (coloured segments).

Coal Mine Methane Emissions in the Czech Republic

Czechia is the third largest coal producer in the EU, with a total 2024 production of 346 352 TJ (*Czechia - Countries & Regions*, 2025), of which 89 % was lignite coal – corresponding to approximately 30 Mt of lignite and 1.2 Mt of hard coal production[1]. The GEM lists five active coal mines in Czechia, four of which are open-pit lignite mines, all located in the Northwest of the country at the border with Germany in the Northern Bohemian and Sokolov Basin coalfields, while the ČSM mine – the only hard-coal mine still operating in Czechia - is located at the border with Poland and is part of the larger Ostrava-Karvina coalfield. The map below (Figure 3) illustrates how lignite and hard coal extraction regions are distributed across the country.

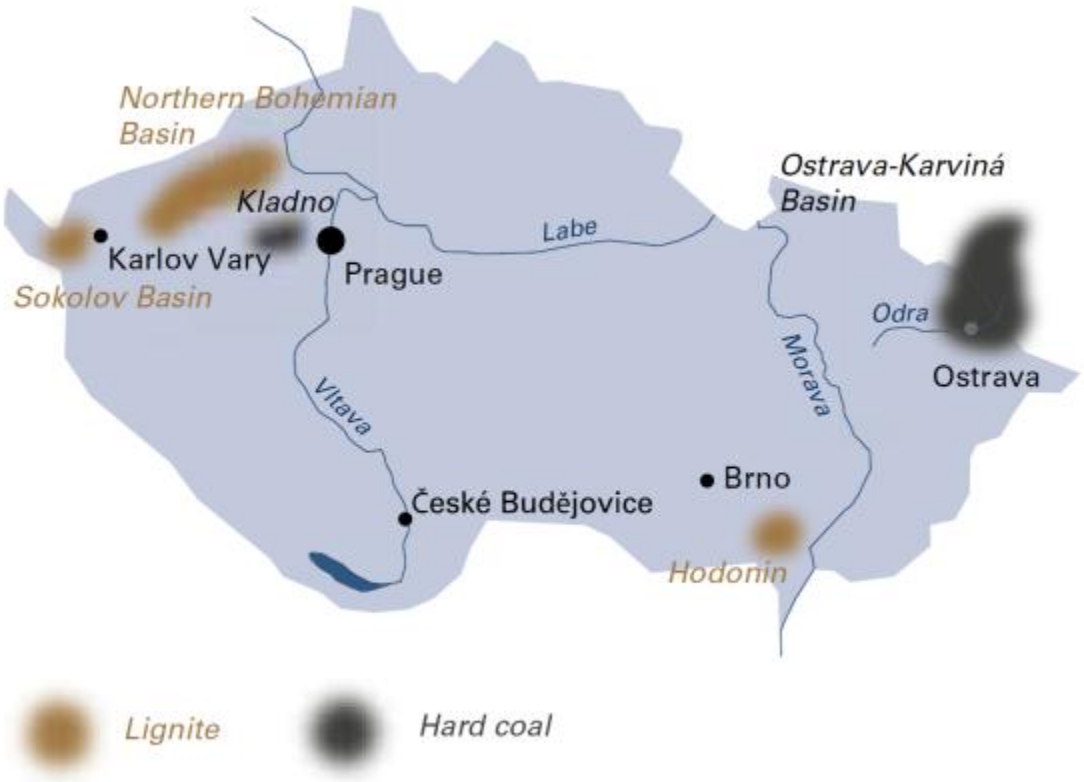

Figure 3: Lignite and hard coal mining areas in the Czech Republic *("Czech Republic," 2024)*.

Review and integration of available data on active coal mines: IMEO Bayesian model

Coal mine methane emissions are generally reported using generic emission factors, expressed in kg methane emitted per 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. The emission factor does not account for regional variations in coal fields and is expected to have significant uncertainties.

The 2023 Czech National Inventory Report (NIR), however, uses Tier 2 for mining emissions, which are country-specific emission factors used to estimate mining emissions from underground and surface mines. The emission factor for underground mines was derived by averaging emissions reported by the Karvina mine operator, OKD, based on data sampled between 2000 and 2008. This represents a substantial improvement with respect to using a generic factor to estimate emissions from the ČSM mine; however, the data has not been independently measured or verified and is not publicly available. It thus remains valuable to consider alternative data sources to establish a robust emission estimate for that mine.

The NIR’s emission factor for surface mines is based on the only accessible empirical study of coal mine methane emissions in the Czech Republic (Buzek et al., 2022). This study found a calculated gas content of 0.31 and emissions of 0.09 m^3/ton of coal produced, or respectively ~0.21 and ~0.06 kg methane/ton of coal produced, substantially lower than the IPCC estimate of 2 m^3/ton for medium emitting surface mines from the 2006 IPCC guidelines (*IPCC, Fugitive Emissions*, 2006) The values found for the Bilina mine are also significantly lower than emission factors measured in lignite coal mines in Poland (Baran et al., n.d.), which range between ~0.6 and 2.5 m^3/ton of coal produced. The fact that Bilina was the only surface mine studied in-situ, while other lignite mines across Northern Bohemia have different mining depth, operators and exploit a different coal seam, does not support the evidence that the Bilina emission factor can be extrapolated to all surface mines in Czechia – further highlighting the need to investigate multiple data sources and produce an independent estimate. Buzek et al, 2022, also lacks to quantify emissions from the surrounding strata, which suggests the possible underestimation of the emission factor (*IPCC, Fugitive Emissions*, 2006).

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. Results from the M2CM are made publicly available in the Coal Mine Tracker Database of the GEM.

The challenge now lies in the integration of these multiple data streams to create an accurate estimate for each active mine in the Czech Republic. For that purpose, we use the IMEO’s Bayesian integration approach (see section “Methods” for further details). This model produces a posterior estimate of a mine’s loss rate (in m^3/ton) based on a prior (here the GEM estimates) and integrates the additional data points that are available (e.g., IPCC Tier 1 default number, in-situ studies) with varying weights. For most Czech Coal Mines, the only inputs are the GEM mine-specific emission factor and the Czech Tier 1 surface or underground coal mine estimate. The estimate for the Bilina coal mine directly uses results from the in-situ study as empirical inputs, while the similarity between Bilina and Vrsany was judged sufficient for the in-situ results to also be inputted into the model for the Vrsany mine – albeit with a lower weight.

The table below (Table 1) compiles the estimates from the various data sources discussed, namely the IPCC and GEM emission factors, and the Bayesian posterior loss rate, as well as the yearly emissions totals for each Czech coal mine. It should be noted here that the confidence level of the central estimates for all the Czech mines is considered low since the input datapoints are very scarce (less than two excluding the prior for most mines), and the relative uncertainty always above 40 % of the central value. The density of gaseous methane is assumed to be 0.67kg/m^3. Our production numbers are drawn from the GEM and are all for 2023.

Table 1. Comparison of methane emission estimates for Czech coal mines based on the IPCC and GEM emission factors, and the Bayesian model.

Mine	**Coal Production**	**Coal Prod Year**	**2023 NIR Tier 2 values**		**GEM**		**Bayesian model**		
Unit	(Mt/y)		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
Bilina Coal Mine	8.3	2023	0.06	0.5	2.51	21	0.26	2.2	0.45
Jiří Coal Mine	3.4	2023	0.06	0.2	0.8	3	0.27	0.9	0.55
Vrsany Coal Mine	7.8	2023	0.06	0.4	1.61	13	0.38	3	0.56
Nástup-Tušimice Coal Mine	7.2	2023	0.06	0.4	1.11	8	0.34	2.5	0.55
ČSM Coal Mine	1.4	2023	8.1	11	19.72	27	12	16	0.45
Total from active coal mines	28	2023	NA	123	NA	68	NA	25	7.8

Taking into consideration the contribution for each individual mine leads to a total estimate of 25 ± 7.8 kt/y, and a range of 17-33 kt/y of methane emissions from active coal mining in the Czech Republic. More than 60% of emissions come from the ČSM underground coal mine, due to close at the end of 2026 - which does not imply it will stop emitting by then.

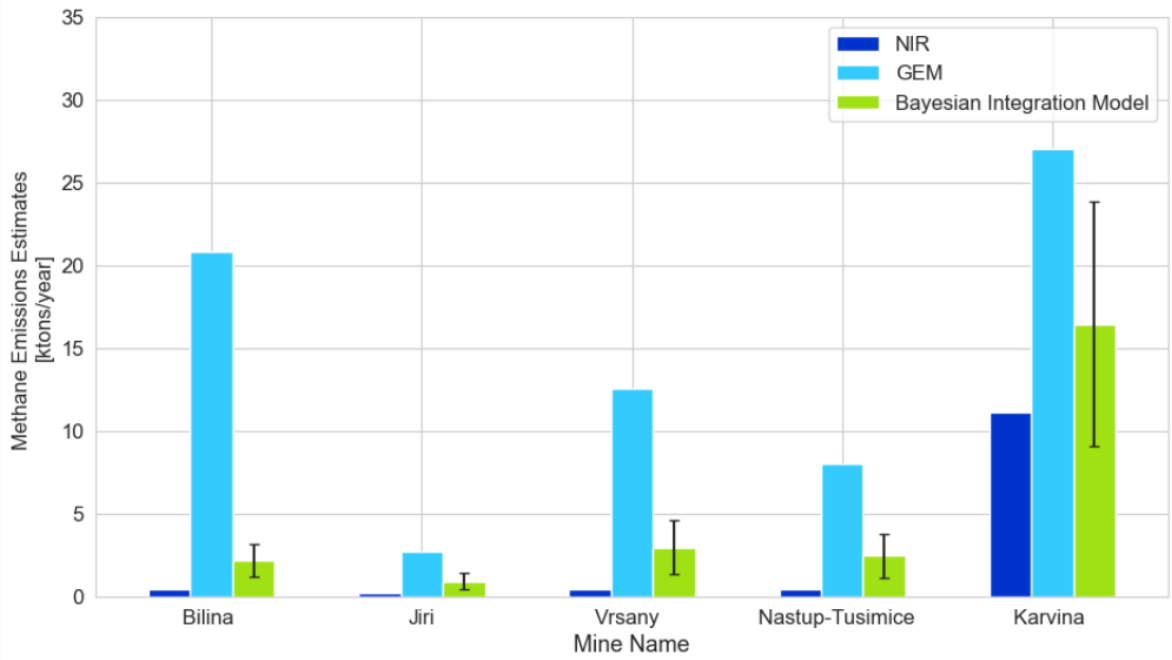

Figure 5: Comparison of emissions for active Czech coal mines.

Discussion of emissions from abandoned coal mines in the Czech Republic

Operating coal mines are not the only potential emitters in the coal sector: abandoned coal mines can continue emitting methane – known as Abandoned Mine Methane (AMM) – for several years after their closure and remain a significant source of methane (Mei & Lerman-Sinkoff, 2024). The Global Coal Mine Tracker (GCMT) ("Global Coal Mine Tracker," 2024) is a worldwide dataset of coal mines and proposed projects. The tracker provides asset-level details on ownership structure, development stage and status, coal type, capacity, production, workforce size, reserves and resources, methane emissions, geolocation, and over 30 other categories. Czechia approved a new National Energy Policy (SEP) aiming to reduce energy consumption and improve the economy's energy intensity. However, reaching the targets of the SEP will require greater effort if the country is to play its part in the global energy transition (*Czechia - Countries & Regions*, 2025). The Czech Republic has a long history of coal mining and many abandoned coal mines. GEM lists 11 coal mines abandoned between the years 2016 and 2023, 10 of which were underground bituminous coal mines. Independent estimates of methane emissions from these abandoned coal mines vary considerably. The 2024 GEM report estimates that the 11 abandoned mines in Czechia emit between 75 and 90 Mcm (or between 50 and 60kt) of methane, depending on their flooding status. Since all abandoned mines of known status – 6 out of 11 – in Czechia are dry, the assumption is made that other mines of unknown status are also dry. The 2023 Czech National Inventory Report, however, claims that 70 % of methane emitted by abandoned mines in Czechia is used by the Green Gas Company for electricity generation. This would bring the GEM estimate for the abandoned mines down to 18 kt of methane per year. Given the uncertainty surrounding the actual degassing efficiency, we use the midpoint between zero-capture (60 kt) and 70 % capture (18 kt) scenarios and use the value for 0 % and 70 % degassing as high and low indicative bounds, respectively. This leads to an emission estimate of 39 ± 21 kt methane from abandoned coal mines in the Czech Republic.

Further field verification of degassing and capture rates, including documentation and reporting of gas recovery volumes and direct measurements is still recommended to refine these estimates.

The 2023 NIR contains estimates of emissions from legacy coal mines by abandonment year group, which we use in lack of better data. To remain conservative and not double count emissions from mines closed between year 2015 and 2021, only emissions from mines abandoned between 1926 and 2001 are considered, with the central assumption that 35 % of methane co-produced along with the coal is being captured. Using the indicative uncertainty factor of twice the initial value from the IPCC guidelines, this adds 4.8 ± 9.6 kt of methane to our previous estimate, yielding a total of ~44 ± 23 kt of methane from abandoned coal mines in the Czech Republic in 2023.

Country-level estimate for the coal sector

Integrating data from the latest 2025 National Inventory Report on post-mining activities, solid fuel transformation and pre-2015 abandoned mines with mine-level estimates from the IMEO's Bayesian model as well as the recalculation of the GEM estimate for post 2015 AMM emissions, results in a total of 69 ± 24 kt of methane emitted from Czech coal operations and legacy coal mines in 2023.

Oil and Gas infrastructure and methane from oil and gas in the Czech Republic

The Czech Republic is the 11th largest natural gas producer and 12th largest oil producer in the European Union. The IEA estimates Czechia's production at approximately 160 million cubic meters of natural gas and 750 thousand barrels of oil in 2024 (*Czechia - Countries & Regions*, 2025), making up approximately ~3% and 2% of Czech natural gas and crude oil supplies, respectively. Czechia additionally imported more than 6 billion cubic meters of gas and 50 million barrels of crude oil in 2024. with the main countries exporting to Czechia in 2023 being Russia, Azerbaijan and Kazakhstan for crude oil and Norway for natural gas (*Database - Eurostat*, 2025). Alternatively, energy data provider Rystad Energy lists domestic production in 2024 of about 300 thousand barrels of oil and 55 million cubic meters of gas, much lower than the IEA number. A document from the Energy Regulatory Office of the Czech Republic (Yearly Report on the operation of the Czech Natural Gas System) provides yet another estimate of around 89 million cubic meters of marketed natural gas in Czechia – which is taken to be the most accurate for the purpose of this analysis, since it is based on gas volumes recorded at metering stations. For oil, the Rystad estimate is used.

All oil and gas production in Czechia can be found in the Vienna and North Carpathian basins, in the East of the country. Rystad lists 5 mainly oil-producing fields - three of them oil only and two mixed - and 26 smaller natural gas fields across the country. The main operators are Moravské Naftové Doly (MND) and Green Gas. MND accounts for 100 % of oil and 51% of gas production, whilst Green Gas accounts for 43% of gas production in the country.

The Czech Republic has a large gas transmission and distribution system, with about 4,000

km of transmission pipelines operated by a single Transmission System Operator (TSO), NET4GAS, and more than 60,000 km of distribution pipelines (Yearly Report on the Operation of the Czech Gas System for 2024, 2025), of which more than 85 % is operated by the Distribution System Operator (DSO) GasNet. Additionally, 5 compressor stations and 3 border transfer stations are distributed across the country, as listed on NET4GAS' website (*Contacts - NET4GAS*, 2025).

Due to Czechia's reliance on oil and natural gas in the transportation, industrial and residential sectors, despite having a relatively low domestic production, most of the oil and gas emissions are expected to come from the mid- and downstream segments; Czechia reported to the UNFCCC in 2025 (inventory year 2023) emissions of 15.3 kt for the whole country, of which around 11.4 kt are from distribution and around 3.3 kt from transmission and storage. These estimates are listed as Tier 2 emission factors, which means they were calculated with country-specific emission factors instead of default values from the IPCC guidelines. Specifically, the latest NIR uses Tier 2 emission factors of 0.117 kg/m^3 methane for oil production, and natural gas emissions of 0.2% of upstream gas production (assuming a 0.94 methane content for the natural gas). The former is from Zanat et al. (1997), while the assumed natural gas intensity of 0.2%, commonly seen as the good practice benchmark within industry, seems to rely on a 1998 report by the International Gas Union – despite neither MND nor Green Gas, the two main oil and gas producers in Czechia, being part of the Union.

Accounting for methane emissions from different sources, the 2025 Czech NIR gives an upstream estimate of 0.70 kt and 0.21 kt of methane emitted as part of operations producing respectively oil (Categories "Oil Production and Upgrading" and "Venting - Oil") and natural gas (Category "Natural Gas Production") in the Czech Republic in 2023. This makes a total of 0.91 kt of emissions from oil and gas production in the country, with an intensity of approximately 1.7 % - more than 8 times the industry-approved good practice threshold of 0.2 %. Following the recommendations of (Seymour et al., 2025), we also include an energy-normalized methane intensity to provide a fuller picture of indicative emissions performance. The energy-normalized methane intensity for combined oil and gas production in Czechia is estimated at 0.17 kg CH_4 per GJ produced.

Although the lack of precise infrastructure and emission data makes it impossible to estimate facility level emissions, a field-level emission-factor can still be derived. Since there are 31 oil and gas production fields in the Czech Republic, we estimate a field to emit on average 3.4 kg/h, or 29.5 tons of methane per year. It is, however, essential to recall that these estimates are based on generic emission factors and do not include any measurement data. They can hence be seen as mostly inaccurate and probably underestimating real emissions. This highlights the need for Czech operators to measure methane emissions and come up with more transparent and accurate estimates, in order to carry out targeted and efficient mitigation measures.

4. Discussion and conclusions

We provide an independent estimate for coal mine methane emissions in the Czech Republic of 69 ± 24 kt/y, corresponding to a range of 45 and 93 kt/y, substantially higher than the 2023 Czech NIR reported value of 21.5 kt. Of the 69 kt/y, ~16 kt are expected to come from underground mining of hard coal, 9 kt from surface mines and 44 kt from legacy mining (abandoned coal mines). This number aims to improve the accuracy of estimates for CMM emissions in Czechia, with the integration of various data sources through the use of a statistical inference method (Bayesian inference).

We compare our results with estimates from the NIR and the GEM. The latter is extrapolated to the country-level by adding post-mining and coal treatment emissions, which were reported to reach 4.6 kt in 2023. The comparison yields the following graph, highlighting the substantial variation in estimates across sources.

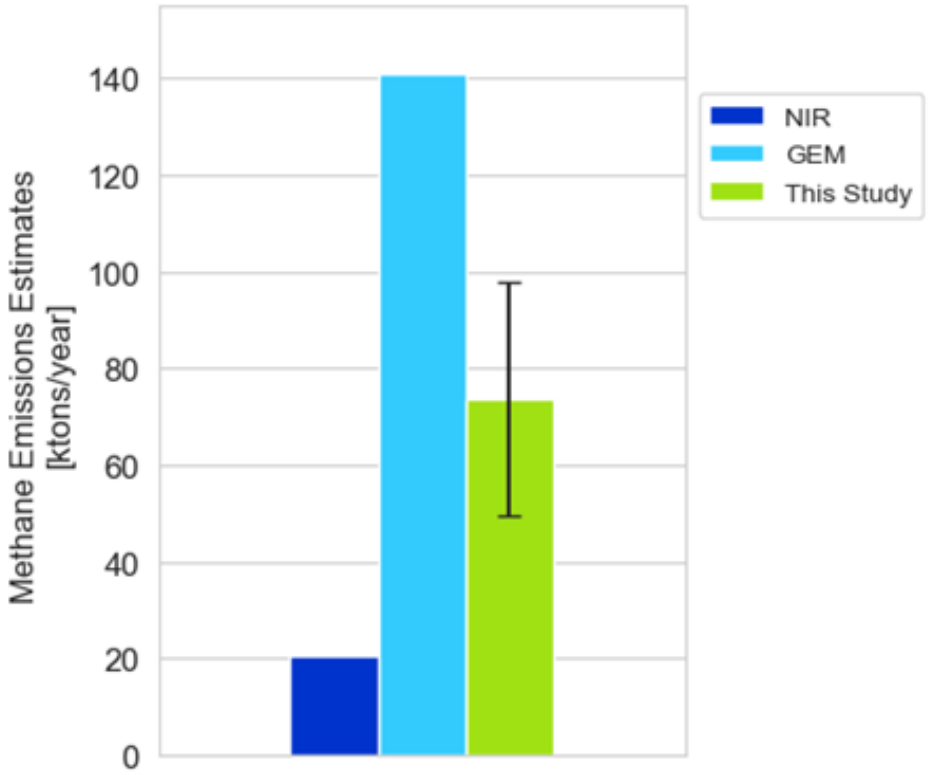

Figure 6 – Comparison of own estimate ("This Study") for Czechia total coal mine emissions in 2023 with reference values from the NIR and GEM.

Our estimate of methane emissions from coal mining is more than three times higher than reported in Czechia's 2023 NIR, and close to 50% lower than the GEM calculated emissions for active and abandoned coal mines. It aligns well with the 2022 NIR total of 67 kt of methane emissions from coal, however, the source breakdown of the two estimates varies

substantially - our estimate attributes most of the emissions to legacy mines whilst surface mining is the primary source in the 2022 NIR.

The discrepancy with IPCC numbers for active coal mines arises from the assumption made in the last 2023 NIR that all surface mines in the Czech Republic have a similar loss rate as the Bilina mine, for which direct measurements took place in 2020 and 2021. However, there is no concrete evidence to support that assumption; on the contrary, in the nearest surface mine for which an in-situ study took place, Poland's Turow mine, located less than 200 km away from the Bilina mine, it was found that lignite extraction was associated with ~0.5 kg methane emissions / ton of coal produced in 2005 – about 9 times higher than the Bilina emission factor. This suggests that the emission factor for lignite mining can vary substantially within a relatively small geographic area and across mines with similar characteristics (depth, lignite type, etc.). Direct measurements from other mines, including both seam gas content measurements and independent atmospheric measurements, are needed to derive a representative and accurate estimate for surface mining emissions in Czechia.

Our estimate for AMM emissions aims to bridge the gap between UNFCCC reported numbers and the GEM report estimate, which are respectively based on generic emission factors and engineering calculations. On the one hand, the Czech 2023 NIR claims that there has been a 70 % capture rate at abandoned underground coal mines in the Czech Republic since 2011, and has a much lower baseline for gross emissions than the GEM, with an estimate of 11 kt of gross AMM in 2023 against the GEM's estimate of ~60 kt. On the other hand, the GEM report does not account for the potential for recapture and reutilization of AMM emissions, and only considers mines closed between 2015 and 2023. The rarity of transparent data, not only on abandoned coal mining emissions but also on gas recapture rates, makes it difficult to evaluate emissions from abandoned mines with a satisfactory level of confidence.

A 2011 study by the Institute for Geology and Mining of the Ostrava Technical University found that in 2009, about 55 million cubic meters of gas was recovered and reutilized from abandoned mines in the Ostrava Karvina Coalfield. The Czech NIR, on the other hand, estimates 11.3 kt of gross methane from legacy mines across the country, with a 50% recovery rate, leading to net emissions of ~5,7 kt of methane in 2009. However, a 50% recovery rate of 55 million cubic meters would correspond to 110 million cubic meters of gross emissions – much closer to the GEM estimate for 2023 than to the inventory number. This discrepancy highlights the difficulty of establishing precise and reliable AMM emission estimates. At the same time, it also underscores that recovering methane from abandoned mines can be a cost-effective mitigation option that contributes both to emissions reductions and to domestic energy supply, an increasingly relevant issue in the current energy security context.

The UNFCCC inventory reports are the main publicly available and relatively granular source of methane emission data for the oil and gas sector in the Czech Republic. However, these estimates are largely based on generic emission factors or, where country specific factors are used, on data that may not be representative, updated, or not follow best practice in its measurement protocol. Consequently, the Czech inventory totals for oil and gas emissions should be regarded as indicative rather than fully representative of the actual level of emissions across the Czech oil and gas supply chain. The methane intensity estimate presented in this report is therefore intended for methodological and benchmarking purposes, rather than as definitive quantification. The methane intensity

calculated in Section 3 amounts to approximately 1.7 %, which is already considered high, and measurement-based studies frequently report even higher emissions. This suggests that even in a small oil and gas production country such as Czechia, there still exists the potential for real mitigation.

All our estimates come with large error bars. These high uncertainties can in part be explained by the scarcity of empirical data on methane emissions from the energy sector in the Czech Republic. Only regular, measurement-based reporting can lead to a substantially higher accuracy for the estimates – which is already required by the EU Methane Regulation, as of August 2024.

5. Policy and economic perspective

Consistent measurement, transparent reporting, and independent verification of methane emissions are crucial for assessing mitigation effectiveness and guiding evidence-based methane policy in the Czech Republic. Variability in geological characteristics, weather patterns and operational practices are among the key factors explaining why methane emissions intensity differs greatly from one fuel exploitation site to another, and, as shown through the many diverging estimates from the energy and in particular coal sector in Czechia, why our current knowledge remains incomplete. The EU Methane Regulation, as the first global rule which requires regular measurement, reporting and verification (MRV) of methane emissions across the energy sector, aims to bridge this knowledge gap and implement more targeted and efficient mitigation measures throughout the entire value chain of the EU's energy consumption.

As of August 2025, the EU Methane Regulation requires measurement-based reporting from coal mine operators of methane emitted from both underground and surface mines, while similar requirements are gradually coming into play for oil and gas operators: the first source-level measurements are required to be submitted by an operator to their competent authority by February 2026 and should be reconciled with site-level measurements by February 2027. An inventory of abandoned coal mines is also required from all Member States since August 2025, while requirements on the measurement of abandoned coal mine methane emissions enter into force in May 2026.

Emissions from underground, both active and closed, coal mines also need to be addressed and mitigated, with a venting prohibition starting in 2027 for the highest emitting active mines and being fully enforced from 2031 onwards for active mines emitting more than 3 kt of methane per year, while a mitigation plan should be submitted for abandoned mines before February 2027, and venting from all potentially emitting point sources prevented from 2030 onwards.

The Czech Republic has a single underground mine still in operation in the Ostrava-Karvina coal basin, and its closure is planned by February 2026 (*Czech Coal Mining*, 2025) , thus meaning that it will not be required to comply with the mitigation measures outlined in the regulation for active coal mining operations. Our independent estimate for the ČSM mine is ~16 kt of methane emitted per ton of coal produced, which is three times higher than the emissions threshold for mines with a venting prohibition starting in 2027 as set in the EU Methane Regulation. Underground abandoned coal mines are thought to emit significant levels of methane emissions, making it essential that continuous measurements take place on all potential point sources of the mine even after its closure. Targeted mitigation measures should also still be implemented, since a mine closure does not guarantee a substantial decline in emissions. The most common way to prevent methane leakage from underground active and abandoned mines is through gas recapture and reutilization techniques, which is claimed to already be implemented in other abandoned mines across the Ostrava-Karvina Coal Basin with a 70% recapture efficiency. There is, however, a lack of transparency on actual gas recapture efficiency in Czech underground coal mines, which prevents us from quantifying potential reductions with certainty.

To account for the uncertainty in reported gas recapture efficiency, we explored a range of plausible scenarios based on existing literature and inventory assumptions. Four cases were considered: (1) 0% (no capture, worst case), (2) 35% (baseline assumption based on Hudeček et al., 2011), (3) 50% (current efficiency assumed in the 2023 NIR), and (4) 70% (upper bound reported for Czech abandoned mines). An aspirational 90% capture efficiency was also included to illustrate the maximum potential for mitigation.

Under our baseline assumption of 35%, increasing capture efficiency to 70% would lead to methane savings of more than 32 kt per year, equivalent to about 52 million cubic meters of recovered gas — almost two thirds of Czechia's reported natural gas production in 2023. Regardless of the current capture level, these scenarios confirm that significant methane reductions can be achieved through enhanced AMM recovery and utilization.

Capturing AMM gas through methods such as face degasification has commercial value and represents a substantial resource if harnessed effectively and rerouted to consumer pipelines. For the Czech Republic, monetizing captured gas could offset mitigation costs, contribute to local energy security, and create opportunities for regional redevelopment in former mining areas.

Methane emissions associated with open-pit coal mining are generally considered to be significantly lower than those from underground operations; however, in-situ measurements remain scarce, and the EU-MER's quarterly reporting requirements have the potential to help bridge that data gap. Measurement of methane from surface mining is challenging but possible, as demonstrated by the Buzek et al study and a recent study of open-pit mining emissions in Queensland, Australia (Borchardt et al., 2025), as well as guidelines from the Australian government (UNEP, 2025). Such measurements must involve coal sampling and gas content measurement along the desorption process along with an independent verification through e.g. atmospheric measurements. For that purpose, several methods exist, including the one from Buzek et al which involves gas chromatography and isotope spectrometry. Coal sampling can additionally be coupled with modelling which accounts for parameters such as permeability and porosity of the surrounding strata, desorption and reservoir pressure, etc. Methane emissions from surface coal mines have historically been understudied and this field of research is still undergoing critical developments. Best practice in the field needs to be significantly improved according to experts from the think tank Ember, in particular in the establishment of emission factors representative of actual emissions ("Understanding the Eu's Methane Regulation for Coal," 2025).

From the perspective of the Czech industry, the EU Methane Regulation represents a challenge, since companies will need to strengthen their measurement and reporting capacity, but also an opportunity. It will prevent gas leaks from distribution and transmission systems, increasing gas supply availability, and contribute to revenue generation via AMM gas recovery. It will also contribute to improving scientific knowledge of global methane emissions from surface mining, which is essential to establish realistic future mitigation pathways.

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 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 IMEO's Steel Methane Partnership are anticipated to further enhance empirical understanding of methane emissions. The project aims to combine science, credible data and industry engagement to make methane emissions in steel more visible and actionable. This project will build the first public database of mine-level methane emissions that combines satellite, aerial and inventory data to drive transparency across the steel supply chain (UNEP, 2025). The database will help validate operator-reported information, identify data gaps, and assess the effectiveness of mitigation measures. The integration of these independent systems into Czechia'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. 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 Czechia. 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 Czechia'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 to ensure that empirical findings are effectively incorporated into national inventory improvements.

Appendix

Table A1. Emission Data Summary (2019-2023)

Year	UNFCCC [kt]				
Sector	Gas	Oil	Coal (2022 NIR)	Coal (2023 NIR)	Total
2019	23	1	94	45	117
2020	23	1	67	29	92
2021	23	1	67	29	91
2022	17	1	67	24	86
2023	14	0.9	N/A	21	37

Table A2. IPCC 1996 source categories and subcategories for fugitive CH_4 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

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