

August 2026

Methane Mitigation Policy Frameworks and MRV Systems – Experience and Lessons from the EU & Germany and Recommendations for China



Imprint

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Cover pictures licensed from Adobe Stock.

Project Description

This report is an output of the Sino-German Cooperation on Climate Change – NDC Implementation project, a bilateral initiative by the Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety (BMUKN) in partnership with the Ministry of Ecology and Environment of the People's Republic of China (MEE) carried out by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH together

with China's National Centre for Climate Change Strategy and International Cooperation (NCSC).

The project is implemented on behalf of the International Climate Initiative (IKI) of the Federal Government of Germany. Within the Federal Government, the IKI is anchored in the BMUKN. Selected individual projects are also the responsibility of the Federal Foreign Office (AA). For more information on the project and IKI in China please refer to climatecooperation.cn.

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Publication Date

August 2026

Please cite

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On behalf of:



Federal Ministry
for the Environment, Climate Action,
Nature Conservation and Nuclear Safety



of the Federal Republic of Germany

Abbreviations

3-NOP	3-Nitrooxypropanol
a ⁻¹	Per annum (per year)
AA	Auswärtiges Amt (Federal Foreign Office, Germany)
BImSchG	Bundes-Immissionsschutzgesetz (Federal Emission Control Act)
BMFTR	Bundesministerium für Forschung, Technologie und Raumfahrt (Federal Ministry of Research, Technology and Space)
BMUKN	Bundesministerium für Umwelt, Klimaschutz, Naturschutz und Nukleare Sicherheit (Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety)
BMWE	Bundesministerium für Wirtschaft und Energie (Federal Ministry for Economic Affairs and Energy), before May 2025: Federal Ministry for Economic Affairs and Climate Action — BMWK
CAN	Climate Action Network
CAP	Common Agricultural Policy
CBAM	Carbon Border Adjustment Mechanism
CBM	Coalbed Methane
CCAC	Climate and Clean Air Coalition
CCER	China Certified Emission Reduction
CEOS	Committee on Earth Observation Satellites
CH ₄	Methane
CMM	Coal Mine Methane
CO ₂	Carbon Dioxide
CO ₂ eq	Carbon Dioxide Equivalent
COP	Conference of the Parties
EC	European Commission
ECCP	European Climate Change Programme
EDGAR	Emissions Database for Global Atmospheric Research
EEA	European Environment Agency
EED	Energy Efficiency Directive
EEG	Erneuerbare-Energien-Gesetz (Renewable Energy Sources Act)
EF	Emission Factor
EFSA	European Food Safety Authority
EOD	Eco-Environment-Oriented Development
EPA	Environmental Protection Agency
E-PRTR	European Pollutant Release and Transfer Register
ESR	Effort Sharing Regulation
ETS	Emissions Trading System
EU	European Union
EUR	Euro
FAO	Food and Agriculture Organization
FIT	Feed-in Tariff
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GMI	Global Methane Initiative
GMP	Global Methane Pledge
Gt	Gigatonne

Gt CO ₂ eq a ⁻¹	Gigatonnes of carbon dioxide equivalent per annum
GWP	Global Warming Potential
ICOS	Integrated Carbon Observation System
IEA	International Energy Agency
IED	Industrial Emissions Directive
IEEP	Institute for European Environmental Policy
IEPR	Industrial Emissions Portal Regulation
IGDP	Institute for Global Decarbonization Progress
IGSD	Institute for Governance and Sustainable Development
IKI	International Climate Initiative
IMEO	International Methane Emissions Observatory
IMPEL	European Union Network for the Implementation and Enforcement of Environmental Law
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated Pollution Prevention and Control
ITMS	Integrated Greenhouse Gas Monitoring System (Germany)
KSG	Klimaschutzgesetz (Federal Climate Action Act)
LDAR	Leak Detection and Repair
LNG	Liquefied Natural Gas
LULUCF	Land Use, Land-Use Change and Forestry
MARS	Methane Alert and Response System
MEE	Ministry of Ecology and Environment (China)
MRV	Monitoring, Reporting and Verification
MSW	Municipal Solid Waste
Mt	Megatonne
Mt CO ₂ eq a ⁻¹	Megatonne of Carbon Dioxide Equivalent per Annum
MW	Megawatt
NCI	National Climate Initiative
NCSC	National Centre for Climate Change Strategy and International Cooperation (China)
NDC	Nationally Determined Contribution
OECD	Organisation for Economic Co-operation and Development
OGI	Optical Gas Imaging
OGMP	Oil and Gas Methane Partnership
PAYT	Pay-As-You-Throw
t	Tonne
UBA	Umweltbundesamt (German Federal Environment Agency)
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
WFD	Waste Framework Directive
WtE	Waste-to-Energy
yr	Year

Note: This table includes all standardised units and abbreviations used throughout the report. Emission units were standardised to Mt CO₂eq a⁻¹ (megatonne of carbon dioxide equivalent per annum) formats.

Figures and Tables

Figures

FIGURE 1: Global Methane Emissions (including LULUCF) by region, 2024.....	3
FIGURE 2: Global Anthropogenic Methane Emissions by Sectors	4
FIGURE 3: Methane Emissions from Energy in China, EU and Germany from 1990 to 2024	5
FIGURE 4: Methane Emissions from Agriculture in China, EU and Germany from 1990 to 2024	5
FIGURE 5: Methane Emissions from Waste in China, EU and Germany from 1990 to 2024	5
FIGURE 6: Overview of Methane Monitoring Technologies	51
FIGURE 7: The MARS Process	52
FIGURE 8: Optical Gas Imaging Process	53
FIGURE 9: Drone Methane Detection Over a Landfill	54

Tables

TABLE 1: GWP of methane relative to carbon dioxide (IPCC AR6)	1
TABLE 2: Methane Emission Intensity in the EU, Germany, China, and the World in 2024.....	3
TABLE 3: Overview of Institutional Framework of Methane Mitigation in China.....	11
TABLE 4: Capacity-Building Dimensions of the 15 th Five-Year Plan for Methane MRV.	15
TABLE 5: Tier-Level Comparison of Agricultural Methane Inventory Methods in the EU, Germany and China	27
TABLE 6: Agricultural Sector Methane Policy Instruments Comparison	29
TABLE 7: Tier-Level Comparison of Selected Energy-Related Methane Inventory Methods in the EU, Germany and China	33
TABLE 8: Energy Sector Methane Policy Comparison	35
TABLE 9: Tier-Level Comparison of Waste Methane Inventory Methods in the EU, Germany and China	39
TABLE 10: Waste Sector Methane Policy Comparison	41
TABLE 11: Proposed Simplified Phased Roadmap for China.....	48
TABLE 12: Advantages and Disadvantages of Satellite Monitoring Technology	53
TABLE 13: Advantages and Disadvantages of Optical Gas Imaging Technology	53
TABLE 14: Advantages and Disadvantages of Aerial Surveillance Technology	54

Executive Summary

Methane and the importance of mitigation

Methane is a high-impact greenhouse gas that has contributed approximately 30% of observed global warming since pre-industrial times and has a significantly higher global warming potential than carbon dioxide over both 20- and 100-year time horizons. Due to its strong short-term warming effect and comparatively short atmospheric lifetime, methane mitigation plays an important role in limiting near-term temperature increase and supporting the objectives of the Paris Agreement.

In recent years, methane mitigation has gained increasing international attention through initiatives such as the Global Methane Pledge, the United Nations Environment Programme (UNEP) / Climate and Clean Air Coalition (CCAC) Global Methane Assessment and the development of methane-specific monitoring and regulatory frameworks. At the same time, advances in emissions monitoring, including satellite observations and facility-level measurement technologies, are increasingly shaping methane governance and mitigation approaches.

The growing focus on methane mitigation reflects not only the importance of reducing greenhouse gas emissions, but also the increasing availability of technologies and governance approaches capable of identifying and addressing methane emissions across sectors.

Global and regional methane trends

Global anthropogenic methane emissions are dominated by three sectors: agriculture, energy and waste. Excluding land use, land use change and forestry, agriculture is the largest source globally, followed by fossil energy production and use, and waste management.

China, the European Union (EU) and Germany show distinct but increasingly converging methane emission patterns.

China is the world's largest emitter of anthropogenic methane. Its methane profile is dominated by the energy sector, while agriculture and waste remain important secondary sources. Methane emissions in China remain closely linked to coal production, industrial activity and rapidly developing urban systems.

The EU accounts for a substantially smaller share of global methane emissions and has achieved significant reductions since 1990, especially in the energy and waste sectors. Within the EU, Germany is among the largest methane emitters in absolute terms but shows comparatively low methane intensity per unit of gross domestic product (GDP) and per capita relative to both the EU average and China.

Differences in sectoral composition strongly influence mitigation pathways, governance approaches and implementation conditions. While the EU and Germany increasingly face the challenge of addressing residual methane emissions from agriculture and waste, China continues to combine large energy-related methane emissions with rapidly expanding urban and industrial systems.

Comparative governance approaches in the EU, Germany and China

The report compares methane emission trends and mitigation approaches in China, the EU and Germany to better examine how methane governance has evolved under different institutional, economic and sectoral conditions. Rather than directly benchmarking countries, the analysis identifies how different policy approaches, implementation capacities and sectoral structures shape methane mitigation pathways in the EU and Germany, and what lessons may be relevant for strengthening methane mitigation in China.

The EU has progressively expanded methane governance from indirect regulation through broader environmental and climate legislation towards more explicit methane-specific frameworks. The 2020 EU Methane Strategy established cross sector priorities, while the 2024 EU Methane Regulation introduced binding methane related obligations in the energy sector, including monitoring, reporting and verification (MRV) requirements, leak detection and repair obligations and measures addressing methane emissions along fossil fuel supply chains.

Germany has combined EU-level instruments with national climate and sectoral policies. Significant methane reductions have been associated with structural changes in the energy and waste sectors, including coal phase-out policies, expansion of renewable energy and biogas systems, landfill diversion measures and improved waste treatment infrastructure. Methane is primarily addressed within broader greenhouse gas reduction frameworks and sectoral policies rather than through a standalone methane law.

China has gradually integrated methane mitigation into broader climate and development strategies. Early policies focused mainly on coal mine methane

utilisation and biogas development, while methane governance has expanded significantly since 2021 under China's 'Dual Carbon' goals of peaking carbon dioxide emissions before 2030 and achieving carbon neutrality before 2060, as well as through the 14th and 15th Five-Year Plans and the 2023 Methane Emission Control Action Plan. The Action Plan represents China's first comprehensive national methane policy framework covering the energy, agriculture and waste sectors and places increasing emphasis on inventories, MRV systems, technology development and co-ordinated implementation.

The comparative analysis suggests that methane governance generally evolves progressively over time. In all jurisdictions examined, early approaches focused mainly on inventories, pilot programmes and broader environmental or sectoral policies before gradually expanding towards more integrated methane-specific governance approaches supported by strengthened MRV systems, regulatory frameworks and implementation mechanisms.

MRV systems and methane governance

The report highlights the important role of MRV systems in supporting methane mitigation governance. Compared to carbon dioxide, methane emissions are often more heterogeneous, diffuse and intermittent, creating additional challenges for monitoring and quantification.

The comparative analysis suggests that the EU and Germany have progressively developed more advanced methane MRV systems by combining Intergovernmental Panel on Climate Change (IPCC)-based inventories with statistical systems, regulatory reporting obligations and measurement-based approaches. In the energy sector in particular, methane governance has become increasingly linked to facility level monitoring and remote sensing technologies.

China is also strengthening its MRV architecture for methane and other non-carbon dioxide (CO₂) greenhouse gases. Important progress has been made in inventory development, methodological updates and data systems, although challenges remain related to data availability, institutional coordination and the integration of measurement based approaches across sectors.

The analysis further suggests that progressively strengthening MRV systems can support the development of more targeted regulatory frameworks and economic instruments by improving emissions visibility, institutional coordination and implementation capacity. At the same time, the effectiveness of MRV systems remains closely linked to sectoral conditions, technological capabilities and broader governance structures.

Sectoral methane mitigation pathways

Across the energy, agriculture and waste sectors, methane mitigation opportunities and governance conditions differ substantially.

In the energy sector, major mitigation opportunities include coal mine methane capture and utilisation, leak detection and repair (LDAR) programmes, improved venting and flaring practices and the reduction of methane emissions along fossil fuel supply chains. Due to concentrated emission sources and comparatively mature detection technologies, the energy sector has generally seen the most advanced development of methane-specific regulation and measurement approaches.

In the agriculture sector, methane mitigation is more strongly constrained by biological processes, diffuse emission sources and food security considerations. Mitigation approaches include livestock management improvements, feed optimisation, manure treatment and anaerobic digestion, as well as

water-saving rice cultivation practices such as alternate wetting and drying. Compared to the energy sector, agricultural methane governance remains more dependent on broader agricultural and rural development policies.

In the waste sector, landfill management, wastewater treatment and organic waste handling represent key mitigation areas. Experience in the EU and Germany suggests that landfill diversion policies, landfill gas capture, separate waste collection systems and waste-to-energy infrastructure can contribute significantly to methane reductions. In China, rapid urbanisation and expanding waste infrastructure create both increasing mitigation needs and opportunities for improved methane management.

The report further highlights that methane mitigation remains uneven across sectors in all jurisdictions examined. While methane-specific governance approaches have advanced most strongly in the energy sector, agriculture and waste sectors continue to face more significant implementation and monitoring challenges. As relatively low-cost reductions in coal, oil and gas systems are progressively exhausted, agriculture and waste are likely to account for a growing share of residual methane emissions.

Lessons and policy implications for China

The comparative analysis highlights that methane mitigation pathways are shaped not only by emission profiles, but also by institutional maturity, governance structures and implementation conditions. Approaches that are effective for concentrated industrial emissions may not be directly transferable to diffuse biological emission sources, requiring differentiated governance and implementation approaches across sectors.

The comparison with the EU and Germany suggests that methane governance generally

evolves progressively from inventories and pilot measures towards more integrated MRV systems, regulatory frameworks and implementation mechanisms. This process is closely linked to improvements in emissions visibility, institutional coordination and sector-specific implementation capacity.

For China, the analysis suggests that strengthening methane mitigation will likely depend on the continued development of sector-specific MRV systems, clearer institutional coordination and the gradual integration of methane mitigation into broader climate, environmental and sectoral governance frameworks under the 'Dual Carbon' strategy.

The analysis further indicates that near-term mitigation opportunities remain concentrated in coal, oil and gas systems, where more advanced monitoring technologies and comparatively mature governance approaches may support relatively rapid emission reductions. Over time, however, the relative importance of agriculture and waste is likely to increase, requiring more differentiated and longer-term approaches linked to agricultural modernisation, infrastructure

development and broader environmental governance transformation.

Drawing on the comparative analysis, several broader governance priorities emerge for strengthening methane mitigation in China. These include progressively strengthening methane MRV systems and data quality, expanding sector-specific regulatory frameworks, supporting implementation through economic instruments and pilot programmes, strengthening coordination between climate, environmental, agricultural and energy authorities and encouraging differentiated provincial implementation approaches reflecting differing economic structures, sectoral conditions and governance capacities.

The report emphasises that methane mitigation pathways cannot be fully standardised across jurisdictions. Experience in the EU and Germany provides important insights into governance sequencing, MRV development and institutional integration. However, effective methane mitigation in China will depend on adapting these approaches to national and provincial conditions, sectoral structures and longer-term development priorities.

Table of Contents

Imprint	ii
Abbreviations	iii
Figures and Tables	v
Executive Summary	vi
Table of Contents	x
Chapter 1: Introduction and Context	1
Methane emissions data, uncertainty and monitoring approaches	1
Global methane emissions, regional distribution and sectoral patterns	2
Global developments on methane mitigation and the need for action	6
Report approach and structure	7
Chapter 2: High-level Overview of Methane Emissions and Policy Context in China	8
Status-quo of methane emissions profile and sectoral structure	8
Evolution of methane policy in China	9
Regulatory framework and sectoral implementation	10
Energy sector	11
Agriculture sector	12
Waste sector	13
Cross-sectoral assessment	13
MRV systems and data requirements	14
Economic instruments	16
Key gaps and structural challenges	18
Chapter 3: Experiences of Methane Mitigation in the EU and Germany	19
Methane emissions profile and sectoral structure	19
Evolution of EU and German methane policy framework	20
The European Union	20
Germany	22
MRV systems in the EU and Germany: from inventory to regulatory tool	23
Sectoral application of policy instruments	24
Agriculture sector	25
Energy sector	30
Waste sector	36
Chapter 4: Comparative Insights, Lessons Learned and Applicability	42
Structural determinants of methane governance effectiveness	42
Governance sequencing and institutional evolution	43
Limits of policy transferability	44
Strategic implications for China	44
Chapter 5: Policy Recommendations and Roadmap	46
Approach for methane mitigation in China	46
Strengthening methane MRV systems and data quality	46
Economic instruments	47
Phased roadmap for methane mitigation	47
Short-term priorities: strengthening the foundations	48
Medium-term actions: expanding and integrating policy frameworks	49
Long-term transformation: achieving systemic methane reduction	49
Provincial application, scaling and transferability	50
Annex 1: Overview of Methane Monitoring and Measurement Technologies	51

Chapter 1: Introduction and Context

Methane (CH₄) is a potent greenhouse gas (GHG) and is responsible for approximately 30% of the net warming experienced globally since the pre-industrial era^[1]. It is the second most important anthropogenic greenhouse gas after CO₂ and has a significantly higher global warming potential (GWP) per unit emitted compared to CO₂.

Its emissions originate from both fossil sources, such as coal, oil and gas systems, and biogenic sources, including agriculture and waste. While both types have a similarly strong warming effect, their global warming potentials vary slightly, as shown in Table 1.^[2]

TABLE 1: GWP of methane relative to carbon dioxide (IPCC AR6)

Methane Type	GWP (20-year horizon)	GWP (100-year horizon)
Biogenic methane	79.7	27.0
Fossil methane	82.5	29.8

Due to its potent warming effect and relatively short atmospheric lifetime, methane plays a disproportionate role in driving near-term climate change. Understanding the sources, trends, and mitigation potential of methane emissions is critical for achieving the Paris Agreement overarching goal to 'limit the increase in the global average temperature to well below 2°C above pre-industrial levels' and pursue

efforts 'to limit the temperature increase to 1.5°C above pre-industrial levels.'^[3]

Methane emissions data, uncertainty and monitoring approaches

Estimating methane emissions remains challenging due to the diversity and nature of emission sources across sectors.^[4]

Emissions arise from a wide range of activities and are often spatially dispersed and variable over time.

Two main approaches are used to quantify methane emissions: observation-based top-down atmospheric inversion and activity-based bottom-up inventories. Each

approach has inherent limitations. Bottom-up estimates depend on the availability and accuracy of underlying data and emission factors, particularly in sectors such as agriculture and waste, where biological processes are complex. Top-down methods provide independent means of assessing emissions but often offer less precise attribution to specific sources and regions.^[5]

^[1] IEA, 'Methane Abatement'

^[2] GHG Institute, 'IPCC AR6 Methane GWP Tables'

^[3] UNFCCC, 'The Paris Agreement'

^[4] Allen, D. et al., 'Scientific Challenges of Monitoring, Measuring, Reporting, and Verifying Greenhouse Gas Emissions from Natural Gas Systems'

^[5] M. Saunio et al., 'Global Methane Budget 2000-2020'

These challenges in accurately quantifying methane emissions have been a central driver in the evolution of MRV systems. Early methane MRV systems relied primarily on national greenhouse gas inventories developed under the IPCC guidance for reporting to the United Nations Framework Convention on Climate Change (UNFCCC). While these approaches ensured international comparability, they relied on default or averaged emission factors and relatively infrequent activity data, limiting their ability to capture spatial variability, episodic emissions and high-emitting sources.^{[6][7]}

As atmospheric observations expanded, including through satellite and in situ measurements, inversion studies frequently found methane emissions to be higher than reported in inventories, suggesting that reliance on inventories alone can underestimate both the magnitude and spatial distribution of mitigation opportunities. At the same time, policy demand for more granular and credible data increased, particularly in the context of the Paris Agreement and emerging national methane strategies. Policymakers increasingly require facility- and source-level information to design and enforce performance standards, LDAR requirements and sector-specific mitigation targets.^[8]

In response, methane MRV systems have progressively incorporated more advanced measurement and monitoring technologies and analytical approaches. Continuous monitoring at high-risk facilities, higher resolution satellite observations (e.g. TROPOMI and GHGSat), and targeted mobile surveys now enable the detection of large emission sources and events on much

shorter time scales than annual reporting cycles. While coverage and revisit frequency remain uneven, these systems increasingly allow regulators and operators to identify and prioritise high-emitting sources.^{[9][10]} An overview of key methane monitoring technologies is provided in Annex 1.

In parallel, methodological advances, particularly inverse modelling, data fusion and multi-scale integration frameworks, have enabled the reconciliation of top-down observations with bottom-up inventories. These approaches use atmospheric constraints to improve the spatial and temporal resolution of emission estimates while maintaining links to underlying activity data required for policy and reporting.

These developments have improved the robustness of methane emissions data, particularly in sectors with concentrated sources such as energy, while uncertainties remain more pronounced in sectors characterised by biological processes. Differences in MRV capacity across countries and sectors therefore influence both the accuracy of reported emissions and the identification of mitigation opportunities and should be considered when comparing emission patterns across regions, although available data provide a sufficiently robust basis for such analysis.

Global methane emissions, regional distribution and sectoral patterns

Based on the Emissions Database for Global Atmospheric Research (EDGAR) Community

^[6] IPCC, 'Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories'

^[7] UNFCCC, 'Key differences between the Revised 1996 IPCC Guidelines'

^[8] IPCC, '2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories'

^[9] Schneising et al., 'Zonal variability of methane trends derived from satellite data'

^[10] Dowd et al, 'First validation of high-resolution satellite-derived methane emissions from an active gas leak in the UK'

GHG database, total global anthropogenic methane emissions (excluding land use, land use change and forestry, LULUCF) amounted to approximately 9.5 Gt CO₂eq a⁻¹ in 2024 (17.9% of all global GHG emissions).

The geographical distributions of methane emissions as visualised in Figure 1^[11] show that China is the world's largest methane emitter, representing 15.7% of global methane emissions (excluding LULUCF) in 2024. In comparison, the EU accounted for 4.5%. Within the EU, Germany (approximately 12.9%) is the second largest emitter of methane emissions after France (approximately 15.7%).^[12]

While China’s total methane emissions are much higher than those of the EU and Germany, a direct comparison of absolute values is of limited relevance given the large differences in population size and economic scale. To enable a more meaningful assessment, Table 2^[13] shows the emissions intensities per unit of GDP and per capita. These normalised indicators indicate that Germany, the EU and China have lower methane emission intensities per unit of economic output compared to the world average. However, Germany performs best in this comparison, closely followed by the EU, while China still has relatively higher

methane intensities. A similar pattern can be observed for per capita intensities, although the difference between China and the EU is comparatively small.

Globally, methane emissions are primarily driven by three sectors: energy, agriculture and waste. The relative contribution of these sectors varies across regions, reflecting

FIGURE 1: Global Methane Emissions (including LULUCF) by region, 2024.

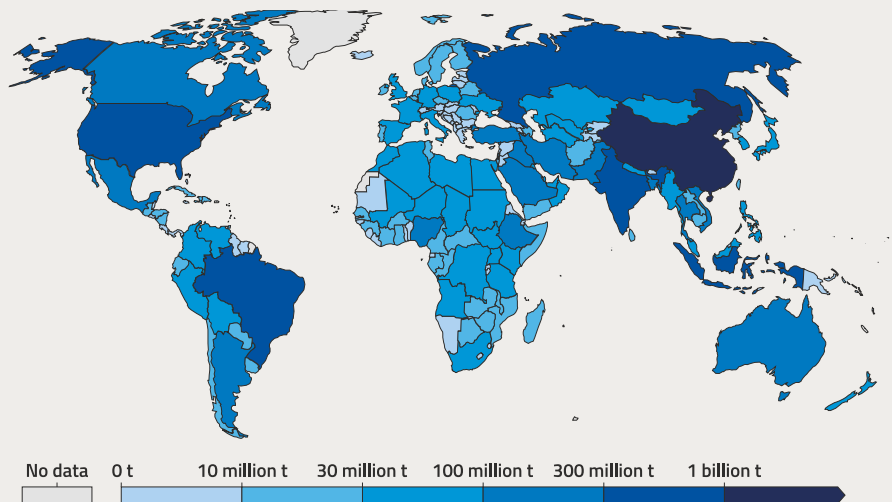


TABLE 2: Methane Emission Intensity in the EU, Germany, China, and the World in 2024.

Country / Region	CH ₄ Emissions per GDP (t CO ₂ eq/USD 1,000)	CH ₄ Emissions per Capita (t CO ₂ eq/person a ⁻¹)
EU (27)	0.017	0.964
Germany	0.011	0.670
China	0.044	1.038
World	0.055	1.175

[11] Our World in Data, ‘Annual methane emissions including land use’

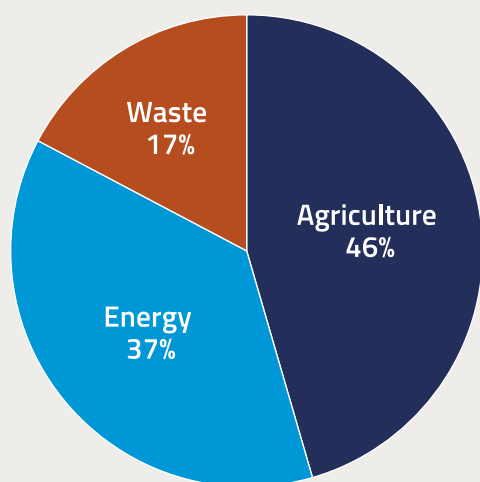
[12] Unless specified otherwise, sources of all methane emissions data in this report are from EDGAR, ‘GHG emissions of all world countries – 2025 report’

[13] Based on EDGAR, ‘GHG emissions of all world countries – 2025 report’

increasingly important source, particularly in rapidly urbanising regions.

Figure 2^[14] shows the share of each sector in the global anthropogenic methane emissions, not considering the LULUCF sector.

FIGURE 2: Global Anthropogenic Methane Emissions by Sectors



Methane emissions differ across sectors in terms of their underlying processes, sources and mitigation potential.

In the **agriculture sector**, the largest source, accounting for approximately 46%, methane emissions are largely driven by biological processes, particularly enteric fermentation and manure management in livestock and rice cultivation. These emissions are more diffuse and depend on natural processes, making them more difficult to monitor and mitigate. Agricultural methane reduction also requires integrating climate objectives with food security, farmer livelihoods, and rural development priorities.

In the **energy sector**, the second-largest source, accounting for approximately 37%, methane emissions primarily result from the

extraction, processing and distribution of fossil fuels, including coal, oil and natural gas. These emissions are often associated with leakage and venting and can be highly variable across sites and over time. Yet the energy sector is also the sector where technological solutions can be applied and regulations enforced most straightforwardly.

In the **waste sector**, accounting for approximately 17%, methane emissions arise mainly from the decomposition of organic matter in landfills and wastewater systems. Emission levels are influenced by waste management practices, infrastructure and the degree of methane capture and treatment. The waste sector offers some of the most cost-effective methane mitigation opportunities, primarily through landfill gas capture and wastewater treatment improvements.

While these sectoral characteristics are broadly consistent globally, their relative importance and evolution differ significantly across countries. To illustrate how these differences translate into distinct emission pathways, the following Figures 3^[15], 4^[16] and 5^[17] compare methane emissions across sectors in China, the EU and Germany.

Overall, the EU and Germany reported a continuous decline of methane emissions by 38.3% and 61.1%, respectively, whereas China's methane emission rose by 43.7% between 1990 and 2024.

Methane emission trends and sectoral contributions also differ markedly between China, the EU, and Germany. In China, methane emissions are strongly influenced by the energy sector, while emissions from the waste sector have increased steadily and agricultural emissions have shown more moderate changes. In contrast, the EU and Germany exhibit a consistent downward

^[14] UPM based on EDGAR, 'GHG emissions of all world countries – 2025 report'

^[15] Ibid

^[16] Ibid

^[17] Ibid

FIGURE 3: Methane Emissions from Energy in China, EU and Germany from 1990 to 2024

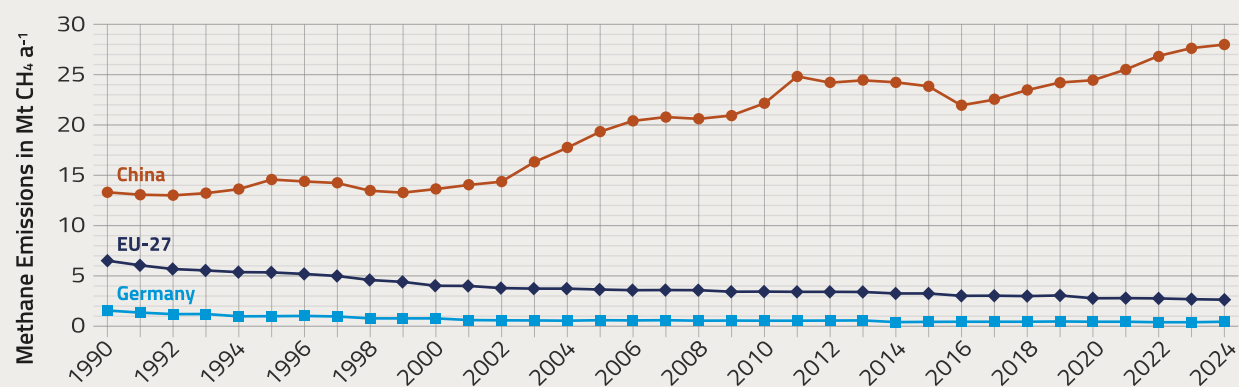


FIGURE 4: Methane Emissions from Agriculture in China, EU and Germany from 1990 to 2024

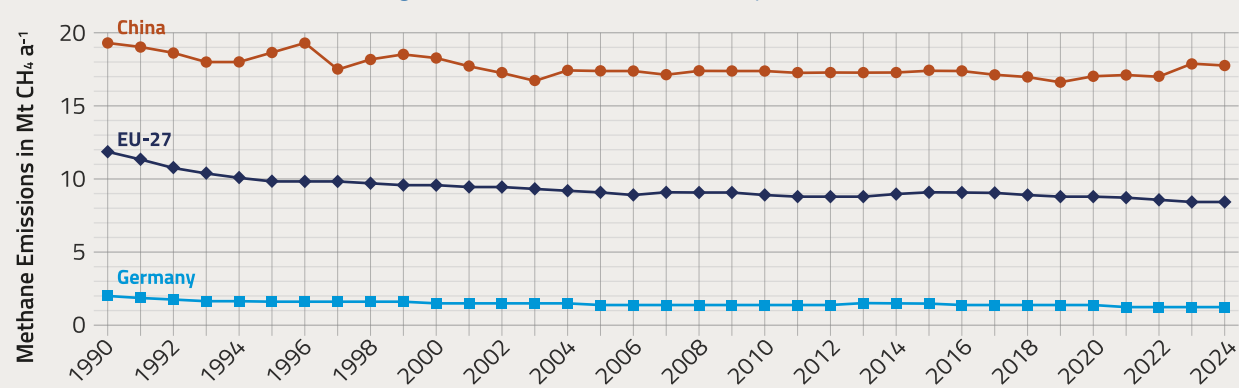
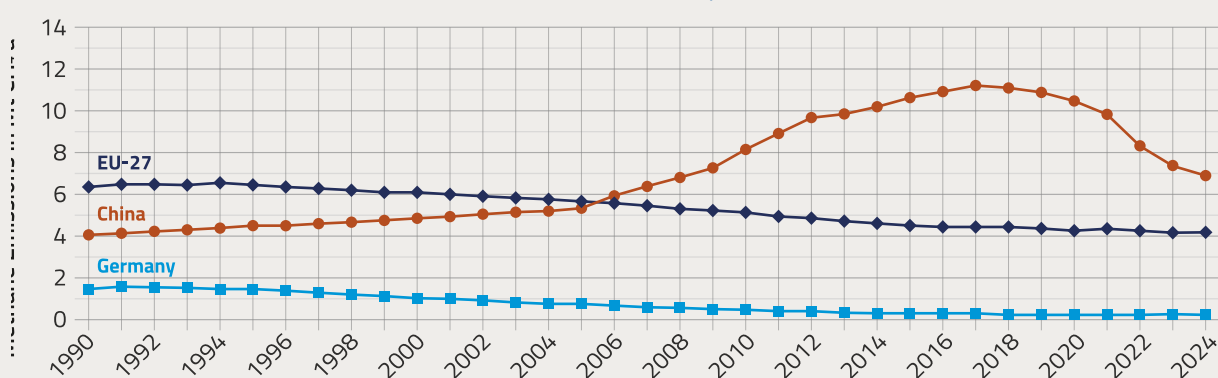


FIGURE 5: Methane Emissions from Waste in China, EU and Germany from 1990 to 2024



trend in methane emissions across the three main sectors. Reductions in the energy and waste sectors have been particularly pronounced, while agricultural emissions have declined more gradually.

Overall, the comparison highlights a structural divergence in methane emission pathways and mitigation outcomes. While methane emissions in China remain closely linked to energy system dynamics and

ongoing economic growth, the EU and Germany have largely decoupled methane emissions from economic activity in key sectors.

In addition to technological advances, these differing emission pathways can largely be explained by the specific mitigation measures and policy approaches implemented across the different jurisdictions, which will be examined throughout this report. At the same time, these regional trends unfold within a broader global momentum towards methane mitigation, shaped by international initiatives and growing recognition that, despite progress in some regions, further action remains necessary.

Global developments on methane mitigation and the need for action

Over the past decade, methane mitigation has become an increasingly important component of international climate governance. International cooperation intensified considerably following the launch of the Global Methane Pledge (GMP) at the 26th Conference of the Parties (COP26) in 2021. Launched jointly by the EU and the United States, the pledge aims to reduce global anthropogenic methane emissions by at least 30% by 2030 compared to 2020 levels. As of 2025, more than 160 jurisdictions had joined the initiative.^[18] Although the GMP does not establish legally binding obligations, it has significantly increased political attention on methane and encouraged the development of national methane strategies and action plans.

Alongside the GMP, several international initiatives and institutions have strengthened the global methane governance landscape. The CCAC leads and supports a suite of global initiatives designed to accelerate action on super pollutants, including methane, and deliver measurable benefits for climate, air quality, human health, food security, and sustainable development. It has supported countries through technical assistance and policy guidance across the energy, agriculture and waste sectors.^[19] In the fossil fuel sector, the Oil and Gas Methane Partnership (OGMP 2.0), coordinated by the UNEP, has become an important framework for improving methane emissions reporting and transparency.^[20]

At the same time, international monitoring initiatives such as the International Methane Emissions Observatory (IMEO) and the Methane Alert and Response System (MARS) have expanded the use of independent methane monitoring and satellite-based detection aiming at setting the standard for methane emissions data.^[21]

Methane mitigation has also gained increasing prominence in international energy and climate assessments. The International Energy Agency (IEA) estimates that around 70% of methane emissions from the fossil fuel sector could be reduced using existing technologies, and that many of these reductions could be achieved at low or even negative net cost.^[22]

While the UNEP/CCAC Global Methane Assessment (2021) estimated that a reduction in anthropogenic methane emissions of approximately 45% by 2030 could avoid nearly 0.3°C of global warming by the 2040s and deliver substantial co-benefits for public health and agricultural

^[18] The Global Methane Pledge, 'About the Global Methane Pledge'

^[19] Climate and Clean Air Coalition, 'About the Climate and Clean Air Coalition'

^[20] UNEP, 'The Oil and Gas Methane Partnership'

^[21] UNEP, 'Eye on Methane Data Platform'

^[22] IEA, 'Global Methane Tracker 2025 – Key Findings'

productivity,^[23] current trajectories remain far from those required to achieve the Paris Agreement goals. The UNEP/CCAC Global Methane Status Report 2025 projects that, under existing legislation, global anthropogenic methane emissions could continue to rise by almost 5% by 2030 rather than decline.^[24]

Report approach and structure

Against this background, the report compares methane emission trends and mitigation approaches in China, the EU and Germany to better understand how methane governance has evolved under different institutional, economic and sectoral conditions. Rather than undertaking a direct benchmarking exercise, **the analysis aims to identify how differing policy approaches, implementation capacities and sectoral structures shape mitigation pathways and outcomes in the EU and Germany, and what lessons may be relevant for strengthening methane mitigation in China.**

The analysis of China is not intended as a comprehensive assessment of methane mitigation, but rather as a high-level contextual overview to anchor the policy recommendations in the specific institutional, economic and sectoral conditions of the country. The focus is therefore on key trends and policy developments relevant for comparative analysis, rather than on an exhaustive sector-by-sector evaluation.

Particular attention is given to the role of methane monitoring and reporting systems, sectoral regulatory approaches and economic incentives, as these elements increasingly shape the implementation and effectiveness of methane mitigation policies across sectors.

Based on this assessment, the report develops policy recommendations and an implementation roadmap for China.

The report is structured as follows:

- **Chapter 2** provides a high-level overview of China's methane emissions profile and policy context, including key sectoral drivers, regulatory approaches, MRV systems and economic instruments.
- **Chapter 3** analyses methane mitigation experience in the EU and Germany, focusing on policy developments, sectoral measures and observed emission trends.
- **Chapter 4** synthesises findings from the comparison, highlighting common patterns, sector-specific challenges and broader lessons emerging across cases.
- **Chapter 5** presents policy recommendations and an implementation roadmap for China.

The analysis draws on peer-reviewed literature, policy documents, expert input and exchanges with Chinese provincial representatives to inform the findings and recommendations presented in this report, reflecting developments up to April 2026.

^[23] UNEP/CCAC, 'Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions'

^[24] UNEP/CCAC, 'Global Methane Status Report 2025'

Chapter 2: High-level Overview of Methane Emissions and Policy Context in China

This chapter provides a high-level overview of methane emissions and the policy context in China. It examines key sectoral drivers, policy developments and governance approaches shaping methane mitigation across the energy, agriculture and waste sectors. It further explores how MRV systems, regulatory approaches and economic instruments have evolved across these sectors.

The chapter focuses on major trends and institutional developments relevant for understanding current methane mitigation pathways and implementation conditions in China.

Status-quo of methane emissions profile and sectoral structure

As outlined in the introduction, EDGAR Community GHG database show that China's methane emissions are primarily driven by the energy sector (53%), followed by agriculture (33%) and waste (13%). The energy sector surpassed agriculture as the largest source of methane emissions in 2004.^[25]

Although the exact sectoral shares differ somewhat from China's official greenhouse gas inventory data reported to the UNFCCC,^[26] both datasets show the same overall pattern, with the energy sector representing the largest source of methane emissions, followed by agriculture and waste. As EDGAR data provide a consistent basis for international comparison, they are used throughout this report to benchmark China's emissions against those of other countries.

The country's energy policy had been supply-oriented and aimed at ensuring energy security to support economic development. Given China's limited oil and gas reserves and abundant coal resources, coal became the backbone of China's growing economy.^[27] China is by far the world's largest coal producer, and coal mining-related emissions account for a substantial share of total methane emissions. With substantial coal mine expansion planned, China is expected to become an even larger emitter of global coal mine methane (CMM) emissions.^[28]

Agricultural methane emissions are 7.6% lower in 2024 compared to 1990,^[29] a comparatively moderate change compared to other sectors. Emissions originate mainly from digestive processes in ruminant

^[25] EDGAR, 'GHG emissions of all world countries – 2025 report'

^[26] The People's Republic of China, 'First Biennial Transparency Report on Climate Change'

^[27] OIES, 'China's Coal Market: Can Beijing Tame 'King Coal'?'

^[28] Global Energy Monitor, 'China's Coal Conundrum: Examining coal mine production, proposals, and methane emissions'

^[29] EDGAR, 'GHG emissions of all world countries – 2025 report'

livestock production and microbial fermentation associated with paddy rice cultivation.^[30] The sector faces the dual challenge of ensuring food security and reducing methane emissions, with heterogeneity and spatial imbalances in the mitigation of methane emissions between provinces.^[31]

In the waste sector, methane emissions have increased by 68.8% between 1990 and 2024. This rise was mainly driven by the increased level of urbanisation,^[32] which reached 67% in 2024, compared to 26.4% in 1990.^[33] Internal migration and related lifestyle transition led to a continuous increase in municipal solid waste and wastewater. At the same time, waste management services remained underdeveloped for a long time.^[34] However, waste-related methane emissions peaked in 2017 and have decreased since then by about 37%.^[35]

Evolution of methane policy in China

China's approach to methane mitigation has evolved from implicit treatment within broader climate and energy strategies to an increasingly explicit, multi-sector mitigation agenda. This evolution reflects both the growing recognition of methane as a high-impact greenhouse gas and the need to address sector-specific emission drivers.

Early phase (1990s-2010): rapid growth and initial sectoral measures

This phase is characterised by rapid economic growth, a coal-dominated energy system and expanding agriculture and waste sectors, which drove sustained increases in methane emissions. Greenhouse gases were mainly addressed under high-level climate statements rather than targeted methane instruments. While early climate policies focused on carbon dioxide, energy efficiency and renewable energy, methane appeared mainly in project-based frameworks such as CMM utilisation and landfill gas projects.

China began building a policy framework around coal mine methane in the 2000s. By 2010, dedicated regulations on CMM emissions and utilisation had come fully into effect, aiming to increase recovery and use of methane from coal seams. However, the gains from CMM utilisation were outweighed by the continued growth in coal production.^[36]

Expansion phase (2011-2019): multi-sector measures integration into national planning

Economy-wide GHG plans started to emerge formalising GHG reduction as a national objective. This included the 12th and 13th Five-Year Plans for Controlling GHG Emissions and the China National Plan

^[30] UC Berkeley, 'China's Methane Action Update (2025)'

^[31] Yu, S., Liu, Z., Sun, L. et al., 'Structural changes and impacts of methane emissions in China'

^[32] Min Zhao, et al., 'Slowdown in China's methane emission growth'

^[33] National Bureau of Statistics of China, 'China Statistical Yearbook 2025'

^[34] Li, J., 'Ways Forward from China's Urban Waste Problem'

^[35] EDGAR, 'GHG emissions of all world countries – 2025 report'

^[36] Miller, S.M., et al., 'China's coal mine methane regulations have not curbed growing emissions'

for Tackling Climate Change (2014-2020). Embedded in the Five-Year Plans, coal exploitation saw a decrease in methane emissions. Approximately 12,000 outdated mines were closed to improve workplace safety, enhance resource utilisation, and reduce overcapacity.^{[37][38]}

At the same time, methane-related actions expanded beyond the energy sector, particularly in waste management, where landfill gas utilisation and wastewater treatment improvements gained importance. However, methane remained largely embedded within broader policy frameworks and was not yet addressed as a distinct policy priority.

Strategic integration (2020-2025): methane as a policy priority

A major shift occurred from 2021 onwards, when methane was formally elevated within China's climate governance framework. The 'Dual Carbon' goals integrated methane into broader climate objectives and highlighted non-CO₂ greenhouse gases as priority targets. The 14th Five-Year Plan explicitly called for strengthened control of non-CO₂ GHGs, improved MRV systems and enhanced policy coordination.^[39]

In November 2023, the Ministry of Ecology and Environment, together with 11 other departments, released the Methane Emission Control Action Plan.^[40] This represents China's first comprehensive policy targeting methane emissions, covering key sectors such as energy, agriculture and waste. It provides top-level design and systematic deployment for methane emission control, marking a significant milestone in China's climate action efforts. It sets targets,

plans, incentives, and MRV for methane reduction.^[41]

The Methane Emission Control Action Plan sets qualitative targets for the 14th and 15th Five-Year Plan periods and outlines actions for inventory establishment and sectoral reductions. It includes measures for simultaneous control of methane and other pollutants, technology innovation, and market incentives. According to estimates by the Ministry of Ecology and Environment, it could support the reduction of methane emissions by 5 million tonnes of CO₂eq by 2030 but does not address emissions from abandoned coal mines.^[42]

Overall, China's methane policy has transitioned from project-based and sector-specific measures towards a more coordinated and strategic approach, although the degree of regulatory binding force remains still limited.

Regulatory framework and sectoral implementation

Regulatory approaches to methane mitigation in China are primarily structured around national planning instruments, sectoral guidelines and an increasing number of technical standards. The outline of the 15th Five -Year Plan, approved in March 2026, reinforces this framework by incorporating non CO₂ greenhouse gas reduction into the broader carbon peaking and carbon neutrality strategy, introducing quantified national targets, expanding

^[37] IGSD, 'China announces actions to promote the development and utilization of coalbed methane'

^[38] Guo, F., et al., 'CHN-CH₄: a gridded (0.1°x0.1°) anthropogenic methane emission inventory of China from 1990 to 2020'

^[39] Khanna, et al., 'An assessment of China's methane mitigation potential and costs and uncertainties through 2060'

^[40] The State Council of China, 'China commits to methane emission control action plan'

^[41] IEA, 'National Methane Action Plan'

^[42] The Ministry of Ecology and Environment of China, 'Promoting Methane Emission Control to a New Level'

sectoral coverage and emphasising ‘governance engineering’, that is, project based and investment driven implementation.^[43] This suggests a regulatory model in which methane control is gaining higher strategic importance but remains embedded in wider planning and implementation systems rather than being governed through a single, stand alone methane law.

Under the Methane Emission Control Action Plan, methane governance involves a multi-stakeholder regulatory framework encompassing eleven central ministries and departments, with implementation supported by provincial governments, local agencies, and research institutions.

TABLE 3: Overview of Institutional Framework of Methane Mitigation in China

Area	Lead Institution	Supporting Institutions
National methane inventory	Ministry of Ecology and Environment	National Development and Reform Commission, National Bureau of Statistics
Coal methane	National Development and Reform Commission, National Energy Administration	Ministry of Ecology and Environment, Ministry of Emergency Management
Agricultural methane	Ministry of Agriculture and Rural Affairs	Ministry of Ecology and Environment
Waste methane	Ministry of Housing and Urban-Rural Development, Ministry of Ecology and Environment	Local provincial governments
MRV system, Satellite monitoring	Ministry of Ecology and Environment	Ministry of Science and Technology, China National Space Administration, China Meteorological Administration, China Academy of Science
China certified emission reduction (CCER) methodologies	Ministry of Ecology and Environment	
International collaboration	Ministry of Foreign Affairs	

Table 3 outlines the sector-specific mandates of these ministries. While the Ministry of Ecology and Environment (MEE) retains overarching coordination authority, methane governance in China remains characterised by a complex institutional framework involving multiple ministries and sectoral responsibilities.

Energy sector

In the energy sector, regulatory measures focus on methane drainage and utilisation in coal mining, supported by emission standards and methodological

updates that increasingly address low concentration methane streams. The 14 Five Year Plan period established coal mine gas utilisation as a core target area, with the Methane Emission Control Action Plan setting a goal of 6 billion cubic metres of annual coal mine gas utilisation. The 15th Five Year Plan shifts from fixed utilisation metrics towards the broader objective of ‘further improving’ utilisation levels and strengthening implementation capacity. This indicates a move from individual utilisation targets towards a more systemic regulatory approach centred on technical deployment, standards and implementation capacity.^[44]

^[43] Government of the People’s Republic of China, ‘China’s 15th Five-Year Plan Outline’

^[44] Ministry of Ecology and Environment of the People’s Republic of China, ‘Methane Emission Control Action Plan’

Coal mines account for the highest share of methane emissions in China, and coal mine methane capture and utilisation projects have continued to expand. The revised mandatory Emission Standard of Coalbed Methane (Coal Mine Gas), GB 21522–2024, strengthens drainage, emission control, monitoring and supervision requirements and lowers the methane concentration threshold above which captured coal mine gas may not be directly released from 30% to 8%. The standard applies to new underground coal mines and coalbed methane development systems from April 2025 and to existing facilities from April 2027. ^{[45][46][47]}

While low-concentration methane, ventilation air methane and associated gas are receiving increasing policy attention, ^[48] emissions from abandoned coal mines and other sources remain less fully integrated into the regulatory framework.

The 15th Five Year Plan also broadens the energy regulatory agenda beyond coal. In oil and gas, one of the most notable new objectives is the intention to ‘strive to gradually achieve zero conventional flares for onshore oil and gas extraction’, alongside a target for associated gas gathering rates in oil fields to reach an internationally advanced level by 2030. These provisions are important because they move methane control in the oil and gas sector from general research and pilot efforts towards clearer regulatory expectations linked to infrastructure build out, associated gas recovery and market based utilisation pathways. ^[49]

Agriculture sector

In the agriculture sector, methane mitigation is addressed mainly through policy guidance embedded in broader agricultural, rural revitalisation and resource efficiency strategies rather than through a dedicated methane regulatory regime. During the 14th Five Year Plan period, the Methane Emission Control Action Plan set a target of 80% or more comprehensive utilisation of livestock and poultry manure. The 15th Five Year Plan raises this to more than 85% by 2030. This points to a gradual tightening of implementation expectations in agriculture, although the policy framework still appears less methane specific and less regulatory binding than in the energy sector. ^[50]

The Methane Emission Control Action Plan further identifies the following priorities for the agriculture sector: advance the resource-efficient use of livestock manure, manage enteric fermentation to reduce methane emissions, and implement phased methane abatement in rice paddies. ^[51] These measures link methane mitigation to wider objectives such as waste reuse, renewable energy generation, agricultural productivity and rural environmental improvement.

Biogas recovery projects from agricultural residues, livestock waste and other organic waste streams continue to play an important role in this area. In regulatory terms, however, these measures function mainly as part of broader circular economy, renewable energy and rural waste management programmes

^[45] Climate Cooperation China, ‘MEE revises Standard for coal mine methane and introduces new methodologies for China’s Voluntary Carbon Market’; MEE, ‘Emission standard of coalbed methane (coal mine gas)’

^[46] Information Institute of Ministry of Emergency Management of China, ‘China Country Update: Progress of Methane Utilization & Emission Reduction in China’s Coal Industry’

^[47] Institute for Global Decarbonization Progress, ‘Outlook for Non-CO2 GHG Emission Reduction: Opportunities and Challenges towards 2035’

^[48] China Daily, ‘Industry leader lauds China’s methane reduction efforts’

^[49] Climate Bonds Initiative, ‘Financing China’s Methane Abatement’

^[50] Ministry of Ecology and Environment of the People’s Republic of China, ‘Methane Emission Control Action Plan’

^[51] Climate Bonds Initiative, ‘Financing China’s Methane Abatement’

rather than as a dedicated agricultural methane control regime.

Waste sector

In the waste sector, methane mitigation is integrated into broader waste management and pollution control policies, including waste classification systems, landfill management, wastewater treatment requirements and resource recovery initiatives. National programmes such as ‘Zero Waste Cities’ support improvements in waste handling and treatment systems, but methane mitigation is usually pursued indirectly through better infrastructure and higher treatment standards rather than through source specific methane regulation.^[53]

The 14th Five-Year Plan period defined two core implementation benchmarks in this area: an urban domestic waste resource utilisation rate of around 60% and a municipal sludge harmless disposal rate of more than 90%. The 15th Five-Year Plan maintains waste treatment as one of the key sectors for non CO₂ greenhouse gas reduction and places it within the broader framework of project-based reduction capacity, indicating continued support for infrastructure-driven methane mitigation rather than a shift to direct methane caps or dedicated methane compliance rules.^[54]

INFO BOX

Examples of methane abatement in rice cultivation in China^[52]

The promotion of intermittent irrigation technology for rice is the most cost-effective measure for reducing emissions. Studies show that water-saving irrigation can significantly reduce methane emissions by up to 77% compared to conventional irrigation. The technology has been widely promoted in provinces such as Anhui and Hunan, but there are challenges in further expansion due to factors such as water resource conditions, labour input, and variety adaptability.

The breeding and application of high-yield and low-emission rice varieties is a direction of technological innovation. China has made a breakthrough in the development of water-saving and drought-resistant rice, which is adapted to water-saving irrigation conditions and reduces methane emissions while achieving stable production with water conservation.

Regenerative rice, as an alternative model, has been promoted on 670,000 hectares in Southwest China and is expected to expand to 3.3 million hectares, reducing emissions by 12% per ton compared to conventional single-cropping rice.

Cross-sectoral assessment

Overall, the regulatory structure for methane mitigation in China remains uneven across sectors. The energy sector has the most developed combination of planning targets, technical standards, project methodologies and emerging sector specific regulatory expectations, while agriculture and waste continue to be governed mainly through broader resource efficiency, rural development and environmental management frameworks. The 15th Five-Year Plan strengthens the cross sectoral architecture by adding quantified non CO₂ targets, extending coverage to chemical production and emphasising stronger laws, standards, economic incentives and enforcement capacity, but it still reflects a gradualist model in which capacity building and project implementation take precedence over binding methane specific regulatory obligations.

^[52] Princeton University Cornell University, ‘Opportunities to Reduce Methane Emissions from Global Agriculture 2021’

^[53] UC Berkeley, ‘China’s Methane Action Update (2025)’

^[54] Ministry of Ecology and Environment of the People’s Republic of China, ‘Methane Emission Control Action Plan’

MRV systems and data requirements

China's methane MRV system has developed rapidly in recent years but remains in transition from a largely inventory based approach towards a more integrated monitoring framework that combines bottom up and top down information. The country has made significant advances in national data systems for methane, including coordination with GOSAT satellite observations and inventory digitalisation under China's Methane Emission Control Action Plan. At the same time, regional studies show that methodological consistency and independent verification lag behind global standards, with satellite inversion comparisons over East Asia revealing discrepancies of around 8–15% between national estimates and atmospheric

inversions, underscoring the need for validated MRV protocols and cross border verification mechanisms. ^[55]^[56]

Recent planning documents explicitly frame methane MRV as a core capacity building priority rather than an area for immediate binding emission caps. The Outline of the 14th Five-Year Plan and the Methane Emission Control Action Plan define non CO₂ greenhouse gas control projects, including methane, nitrous oxide and hydrofluorocarbons, as part of the 'Dual Carbon' strategy and call for a 'significant enhancement' of methane emission statistics, accounting, monitoring and supervision during the 14th and 15th Five-Year Plan periods. The Outline of the 15th Five-Year Plan further emphasises the establishment of an integrated methane monitoring network spanning 'sky, land and space' and the strengthening of MRV maturity as a prerequisite for more stringent, outcome oriented targets. ^[57]

INFO BOX IPCC Inventory Tiers ^[58]

The IPCC's Task Force on National Greenhouse Gas Inventories developed, within the IPCC Guidelines, a tier system that provides countries with a structured way to choose methodological levels for each GHG source category.

The three-level system classifies estimation methods by their complexity and data requirements, allowing inventory compilers to select methods consistent with their resources while applying more sophisticated approaches to key

categories that strongly influence total emissions and trends. As countries improve data and MRV systems, they are expected to move major sources from Tier 1 toward Tier 2 or 3 to enhance accuracy and transparency.

Tier	Description	Data Requirements	Accuracy
Tier 1	Uses IPCC default emission factors and simple activity data.	Low	Lowest
Tier 2	Uses country-specific emission factors and more detailed activity data.	Moderate	Higher
Tier 3	Uses advanced models, detailed measurements, or facility-specific data.	High	Highest

^[55] Liang et al., 'East Asian methane emissions inferred from high-resolution inversions of GOSAT and TROPOMI observations: a comparative and evaluative analysis'

^[56] The Institute of Energy Economics (IEE) Japan / Economic Research Institute for ASEAN and East Asia (ERIA), 'Effective Management of Methane Emissions in ASEAN'

^[57] Ministry of Ecology and Environment of the People's Republic of China, 'Methane Emission Control Action Plan'

^[58] European Environment Agency, 'Tier levels'

Methane emissions in China are currently estimated using a combination of IPCC Inventory Tier 1, Tier 2 and, in selected cases, Tier 3 methodologies, depending on sector and data availability. In the energy sector, higher tier approaches are increasingly applied in parts of the coal and natural gas systems, supported by sector specific methodologies and improved data collection, but coverage remains uneven and emission factors for coal mine methane still carry substantial uncertainty. In agriculture and waste, emission estimates rely more heavily on generalised emission factors and Tier 1–2 methods, with limited facility level measurement data and incomplete representation of regional heterogeneity.^[59]

The 14th Five-Year Plan marked the first time that China has introduced a quantitative target for non CO₂ GHG mitigation at the national Five Year Plan level, aiming to form a capacity to reduce 30 million tonnes of CO₂ equivalent through projects in coal mining, planting and breeding, waste treatment and chemical product manufacturing.^[60] If converted entirely into methane, this would correspond to approximately 1.07 million tonnes of methane (using IPCC AR6 GWP100 = 27.9), indicating a non negligible contribution to global methane abatement. However, the deliberate use of the term ‘reduction capacity’ rather than ‘actual reduction volume’ reflects the current constraints of a weak statistical accounting basis for methane emissions and insufficient local data on emission factors and highlights how MRV limitations shape target design.^[61]

The capacity building orientation of the 15th Five-Year Plan is articulated along three interlinked dimensions that are closely tied to MRV, as shown in Table 4.^[62]

TABLE 4: Capacity-Building Dimensions of the 15th Five-Year Plan for Methane MRV.

Capacity Dimension	Main Content Relevant to MRV and Policy
Monitoring and Accounting	Establishment of an integrated ‘sky–land–space’ methane monitoring network; enhancement of statistics, accounting, monitoring and supervision; maturation of the MRV system
Technical Equipment	Large scale deployment of low concentration gas utilisation technologies, biogas projects and LDAR systems that require standardised measurement and verification
Policy Implementation	Strengthening of laws and standards, economic incentives and law enforcement supervision, providing institutional support for MRV based compliance

These priorities are complemented by concrete technical and institutional measures. In 2025, the MEE and the National Bureau of Statistics jointly launched the first version of the Database of National Greenhouse Gas Emission Factors, designed to provide standardised emission factors across multiple sectors and gases and to be updated regularly. China has also begun operating a methane monitoring network around three offshore oil and gas platforms and conducting monthly satellite remote sensing monitoring of methane emission hotspots. A further regulatory initiative, based on MEE’s draft notice on strengthening methane controls in environmental impact assessments (EIAs) for major industry projects, would require methane emission quantification and control measures mandatory elements of EIAs

^[59] UNFCCC, ‘The People’s Republic of China Fourth Biennial Update Report on Climate Change’
^[60] National Development and Reform Commission, ‘Outline of the 15th Five-Year Plan for National Economic and Social Development of the People’s Republic of China’
^[61] Dialogue Earth, ‘Multiple interpretations: What impact has China’s methane action plan had?’
^[62] Ministry of Ecology and Environment of the People’s Republic of China, ‘Methane Emission Control Action Plan’

for projects in coal mining, oil and gas, livestock, municipal solid waste and wastewater management once adopted.^{[63] [64]}

At the sectoral level, MRV practice remains heterogeneous. In the coal mining sector, China revised the Coalbed Methane (CBM) Statistical Investigation System to improve the timeliness and completeness of data on CBM and CMM drainage and utilisation, and the coal sector has also seen the release of methodologies for voluntary emission reduction projects. In addition, for eligible low-concentration coal mine gas and ventilation air methane projects, the corresponding CCER methodology (detailed further in the section on **Economic instruments**) provides a standardised framework for project design, monitoring and verification, including the connection of project monitoring data to the national carbon market management platform. While the measures are impacting selected large mines, coverage does not reach small and medium sized mines and abandoned mines. For agriculture, emission factors for rice paddies and livestock are largely based on domestic research and national level Tier 2 methods for enteric fermentation and manure management, yet significant regional variation is not fully captured in inventory practice and advanced measurement approaches (e.g. feed intake monitoring, tracer techniques, atmospheric measurements) are mostly confined to research and pilot projects. The waste sector relies primarily on Tier 1 and Tier 2 methods with limited facility level measurement, despite ongoing improvements in landfill and wastewater management that could support more granular data collection.

Rice cultivation is a major methane source in China, and national reporting uses a Tier 3 model (CH₄MOD) that incorporates water management and agronomic data,

while mitigation plans promote alternate wetting and drying and other water saving practices to reduce emissions. Monitoring approaches in other sectors are beginning to incorporate facility level data and pilot applications of advanced technologies such as satellite based detection and remote sensing, and international initiatives such as the MARS and the IMEO are increasingly relevant reference points for China, although integration into domestic MRV systems is still limited.

Overall, while the 15th Five-Year Plan's emphasis on capacity building and integrated monitoring represents a step change in ambition, data availability and quality still vary markedly across sectors and regions, institutional responsibilities for methane MRV are not yet fully standardised, and the reconciliation of bottom up inventories with top down observations is at an early stage, leaving China's MRV framework in a transitional state.

Economic instruments

Economic instruments for methane mitigation in China are implemented through a combination of carbon market mechanisms, green finance instrument and sectoral support programmes. Existing policy and investment frameworks already include a number of methane-related activities, but many references remain high-level and do not yet provide the technical specificity needed to trigger large-scale investment at sector level.

Most provinces encourage the inclusion of methane abatement projects in eco-environment-oriented development (EOD) project databases and support the development of CCER projects. Inclusion in the EOD project databases can qualify the projects for

^[63] Ministry of Ecology and Environment of the People's Republic of China, 'Letter Soliciting Public Comments on the "Notice on Strengthening Methane Control in Environmental Impact Assessments of Key Industry Construction Projects"'

^[64] UC Berkeley, 'China's Methane Action Update (2025)'

municipal subsidies and recommendations by governments to financial institutions, thereby improving access to credit and lowering financing costs for methane-related investments. The 2025 edition of the Green Finance Endorsed Project Catalogue marks an important step by explicitly identifying a wide range of methane-relevant categories, including waste gas recovery equipment manufacturing and trade, and methane reduction in rice cultivation through breed adjustments and low-carbon technologies. These categories are labelled as contributing to GHG reduction, signalling a stronger policy focus on methane abatement within China's green finance framework.^[65]

China's carbon market architecture consists of two main components: the national emission trading system (ETS) that is the mandatory market, and the voluntary CCER market. Methane is not yet covered by the ETS. The CCER mechanism provides the main market-based framework for methane mitigation projects, particularly in the energy sector, where new methodologies have been introduced for key sources. At the end of 2024, with the official notice issued in January 2025, MEE released methodology CCER-10-001-V01 for the utilisation of low-concentration coal mine gas and ventilation air methane with methane concentrations below 8%. By limiting eligibility to methane concentrations below the mandatory 8% emission threshold, the methodology directs carbon-market incentives towards activities that are not already required by the emission standard and may require additional financial support. The MEE also published CCER methodologies for methane in the oil and gas sector regarding the recycling of oilfield-associated gas onshore and offshore (CCER-10-002-V01, CCER-10-004-V01), as well as the test venting gas (CCER-10-003-V01)^[66]. By contrast, methane-specific

CCER methodologies for the agricultural sector have not yet been reinstated since the suspension of the original CCER programme in 2017, limiting the use of carbon market instruments for agricultural methane mitigation.^[67]

Outside the carbon market, financial support in agriculture is mainly channelled through broader rural development and environmental programmes, which include incentives for biogas systems, improved rice cultivation practices and resource-efficient farming methods. China also applies a feed-in tariff (FIT) of RMB 0.75/kWh, including tax, to eligible agricultural and forestry biomass power projects since 2010.^[68] These measures can reduce methane emissions but are usually framed in terms of rural revitalisation, circular economy and pollution control, so explicit methane specific incentives remain limited and often embedded within wider policy objectives. In the waste sector, investment is primarily directed towards infrastructure development, including waste treatment facilities, landfill management systems and wastewater treatment. These investments indirectly contribute to methane mitigation through improved waste handling and processing, rather than through targeted methane pricing or incentive mechanisms.

Overall, economic instruments for methane mitigation in China still play a complementary role. Carbon market methodologies and green finance taxonomies have begun to recognise methane more explicitly, especially in the coal and oil and gas sectors, but instruments are not yet systematically aligned with methane specific mitigation objectives across sectors, and many incentives continue to be framed under broader climate, environmental and development policies rather than as dedicated methane tools.

^[65] Climate Bonds Initiative, 'Financing China's Methane Abatement'

^[66] Ministry of Ecology and Environment of the People's Republic of China, 'Notice on Issuing Three Methodologies Including 'Methodology for Voluntary Greenhouse Gas Emission Reduction Projects: Recovery and Utilization of Associated Gas in Offshore Oilfields (CCER-10-002-V01)'

^[67] Climate Bonds Initiative, 'Financing China's Methane Abatement'

^[68] DBFZ, 'Project: Energetic utilization of agricultural residues in China and Germany'

Key gaps and structural challenges

China's methane mitigation framework is shaped by several structural challenges that affect policy implementation and effectiveness.

Regulatory approaches remain uneven across sectors, with more developed frameworks in energy and less formalised instruments in agriculture and waste. Binding requirements and enforcement mechanisms are still evolving.

While MRV is recognised as a priority by the Methane Emission Control Action Plan, detailed implementation plans and standardised methodologies are still under development. MRV systems vary in coverage and methodological sophistication, with differences in data availability and measurement approaches across sectors. The use of generalised emission factors remains widespread outside the energy sector, and integration of measurement-based approaches is still limited.

Economic instruments are concentrated in specific sectors and project types, with

broader application across sectors still developing. Financial incentives are often embedded in wider policy frameworks rather than targeted specifically at methane mitigation. Despite the increasingly recognised climate importance, methane reduction has not yet received sufficient attention in national policies or commercial financial products. The scale of financing, maturity of mechanisms, and market awareness remain limited.

Sectoral characteristics also influence implementation. The energy sector, with concentrated emission sources, allows for more direct regulatory and monitoring approaches, while agriculture and waste are shaped by dispersed sources, infrastructure constraints and differing institutional conditions.

Overall, while China has made significant progress in recognising methane as a policy priority and establishing the foundations for mitigation, important gaps remain in the integration, binding force and implementation of policy instruments. These gaps are critical for understanding the differences in mitigation outcomes compared to the EU and Germany and form the basis for the comparative analysis in the following chapters.

Chapter 3: Experiences of Methane Mitigation in the EU and Germany

This chapter examines methane mitigation experience in the EU and Germany since 1990, focusing on the evolution of methane emissions, policy frameworks and sectoral approaches across the energy, agriculture and waste sectors.

Methane emissions profile and sectoral structure

Methane emissions in the EU and Germany have evolved significantly since 1990, with important changes not only in overall emission levels but also in sectoral composition.

As emissions declined, the sectoral composition shifted in both the EU and Germany. Agriculture is now the leading source of methane emissions in both the EU (55%) and Germany (61%) —mirroring global patterns— followed closely by the waste sector as the second-largest contributor.

Within the **agricultural sector**, methane emissions are primarily associated with livestock and manure management. In EU, they decreased by 29% between 1990 and 2024, with most reductions occurring before 2010 and stabilising thereafter. A similar pattern can be observed in Germany, where emissions declined by 39%, largely due to reductions in livestock numbers following reunification.

Within the **energy sector**, methane emissions are caused primarily from coal mining, oil, and natural gas operations. In the EU, methane emissions decreased by 58.2% between 1990 and 2024, with the sector's relative share in total methane emissions declining from 26% to 18%. This trend is largely attributable to the reduction in coal mining, lower oil and gas production, and the roll-out of renewable energy.^[69] Germany has been a key driver of this trend, reducing its energy-related methane emissions by 69% over the same period. While domestic fugitive emissions from fossil fuel supply have fallen significantly since 1990, emissions associated with imported fossil fuels are not accounted for in national inventories. This is particularly relevant for Germany as a major fossil fuel importer and highlights that further mitigation potential in the sector increasingly lies in these external supply chains.

In the **waste sector**, the largest contributor to methane emissions is solid waste disposal, primarily landfilling. In the EU, waste-related methane emissions have declined by 35% between 1990 and 2024. This decrease can be explained by increased separate collection, recycling and pre-treatment of waste, as well as the diversion of waste from landfills to biological treatment and energy recovery, landfill gas capture and recovery.^[70] Germany has played a leading role, achieving one of the steepest declines in waste sector methane emissions among EU Member States,

^[69] Ecologic Institute, 'EU 2040 Climate Target: Contributions of the Energy Supply Sector'

^[70] EEA, 'Methane, climate change and air quality in Europe: exploring the connections'

with waste-related methane emissions declining by 81% between 1990 and 2024 and fell by more than 90% between 1995 and 2021, despite increase in population and waste generation of 2% and 6% respectively.

Evolution of EU and German methane policy framework

This chapter describes and compares the evolution of policy frameworks for direct and indirect methane mitigation in the EU and Germany, highlighting how priorities and targets have developed over time and setting the scene for the subsequent analysis of policy instruments.

The European Union

The EU's approach to methane has shifted from implicit, sector-specific measures to a dedicated, cross-sector strategy and binding regulation that now also reaches beyond its borders.

Early efforts (1990–2010): indirect regulation and voluntary initiatives^[71]

Early efforts of methane mitigation in the EU relied largely on indirect or sector-linked regulation, notably the Landfill Directive (1999/31/EC) and the Integrated Pollution Prevention and Control (IPPC) Directive. These directives primarily targeted waste management and industrial emissions, leading to a 24.8% reduction in methane emissions by 2010 compared to 1990.^[72] The Landfill Directive established requirements to reduce the disposal of

biodegradable waste. It mandated gas collection systems for large landfills, which became a cornerstone of EU waste-sector methane mitigation. These regulations affected methane emissions; however, they did not contain methane-specific targets.

Voluntary initiatives, such as the European Climate Change Programme (ECCP) launched in 2000, helped identify abatement opportunities and foster stakeholder engagement, yet the lack of binding targets and enforcement mechanisms limited their impact on emission reductions.

Comprehensive approach (2010–2020): climate ambition and strategy development

From 2010 onwards, EU methane mitigation gradually evolved from indirect sectoral measures towards a more comprehensive strategy. The European Green Deal, launched in 2019, set the broader climate framework by aiming for climate-neutrality by 2050 and achieving at least 55% reduction in greenhouse gas emissions by 2030 (compared to 1990 levels).^[73]

Within this context, the EU Methane Strategy, adopted in October 2020 as part of the Green Deal agenda, outlined a cross-sector approach to reducing methane emissions across all sectors. The strategy identified five key pillars: improving measurement and reporting, reducing emissions in the energy sector, addressing agricultural emissions, mitigating waste sector emissions, and promoting international cooperation. The strategy emphasised the need for better data through enhanced MRV systems, recognising that accurate emission quantification is fundamental to effective policy design and implementation.^[74]

^[71] Wikiwaste, 'IPPC Directive'

^[72] Our World in Data, 'Methane emissions from all sectors'

^[73] European Commission, 'The European Green Deal – Striving to be the first climate-neutral continent'

^[74] European Parliament, 'The new EU Methane Strategy'

**First dedicated law (2024-present):
the EU Methane Regulation**

With the EU Methane Regulation (EU) 2024/1787, a first dedicated law entered into force on 4 August 2024, the EU establishes the first comprehensive EU-wide framework for methane emissions with legally binding requirements, primarily targeting the energy

sector (oil, gas, and coal). The energy sector was chosen as the initial focus because, despite lower domestic emissions than agriculture and waste, it offers the largest and most cost-effective mitigation potential once methane released along imported fossil fuel supply chains is considered, while waste and much of agriculture are already regulated under other EU instruments.^[75]

INFO BOX
Impact Assessment of the EU Methane Regulation ^[76]

The European Commission's impact assessment of the Methane Regulation projects significant emission reductions and co-benefits for the EU. Under the preferred policy option —a package of legislative measures prescribing

compulsory MRV and LDAR, rules on venting and flaring covering the oil, gas and coal sectors, both for operating and closed mines, and a transparency list plus a high methane emitter monitoring tool— the regulation is expected to

reduce EU methane emissions from the energy sector by 77% by 2030. The impact assessment qualifies projected social, environmental, and economic benefits based on three policy areas. The following table summarizes the results.

Policy Area	Type of Benefit	Description
Policy Area 1: Improving measuring and reporting of methane emissions in the EU	Social and Environmental Impact	Improved data quality and better MRV allows for more targeted action, with associated environmental and social benefits
	Economic Impact	Supports high net socio-economic benefits (See Policy Area 2)
Policy Area 2: Mitigation of methane emissions in the EU	Social and Environmental Impact	0.706 Mt CH4 reduction by 2030 (0.377 Mt 2040, 0.317 Mt 2050): prevents 1,010 premature ozone deaths/year, 2,824 asthma accident and emergency visits/year, 64 hospitalizations/year, avoids 102k tonnes of crop losses and 282 million work hours lost to heat/year
	Economic Impact	By 2030, the EU projects EUR 2,573M total benefits at costs of EUR 127M – resulting in a EUR 2,446M net benefit.
Policy Area 3: Measuring, reporting and mitigation of methane emissions linked to EU fossil fuel consumption but occurring outside the EU	Social and Environmental Impact	Outside the EU, methane abatement associated with fossil energy consumed by the EU could reach 25.513 Mt CH4 by 2030: prevents 36,656 ozone deaths/year, 102k asthma visits/year, 2,307 hospitalizations/year, avoids 3.7 Mt crop losses and 10.2 billion work hours lost to heat/year.
	Economic Impact	Assuming optimal abatement (as described above) of the roughly 25.5 Mt CH4, this translates to net socio-economic benefits of around EUR 91 billion by 2030.

^[75] EUR-Lex, ‘Commission Staff Working Document Impact Assessment Report’

^[76] Ibid

Germany

Germany's methane related policy has evolved alongside EU and global frame-works.

Early efforts (1990 – mid-2000s): waste-driven cuts and indirect regulation

From 1990 to the mid-2000s, Germany reduced its methane emissions mainly through waste and coal management measures rather than methane-specific targets. Landfill gas collection has been mandatory in Germany since 1993, with captured landfill gas used for electricity generation 'where technical feasible', cutting landfill methane significantly. The most significant contribution to methane mitigation resulted from the legally binding ban on the landfilling of untreated municipal waste. The ban was first introduced in 1993 through the Technical Guidelines for Municipal Waste, incorporated into the Waste Disposal Ordinance in 2001, entered into force in June 2005, and was effectively implemented through waste acceptance criteria under the Landfill Ordinance from 2009. This ban led to a transformation of the waste sector. The strict acceptance criteria (total organic carbon (TOC) content, respiration activity and gas formation rate) resulted in the most decisive reduction in emissions.^[77]

On the energy side, fugitive methane emissions from fossil fuel provision were mainly driven down by infrastructure modernisation (particularly the replacement of damage-prone grey cast iron pipelines used for natural gas by steel or plastic pipelines), as well as policies such as the EEG introduced in 2000. The EEG caused a reduction of emissions from

decommissioned coal mines thanks to financial incentives for the economic generation of electricity from mine gas.^[78]

Consolidation (mid-2000s – 2010s): system building and integrated climate policy

In 2007, the National System for Emissions Reporting in Germany was institutionalised through a policy paper, and the German Environment Agency (Umweltbundesamt) was designated as the Single National Entity / National Co-ordinating Agency responsible for planning, preparing, storing and quality-controlling GHG inventories, including methane.^[79] Throughout the 2010s, this system delivered detailed annual inventories, which underpinned sector policies and highlighted where gaps remained. While not a reduction instrument itself, it was crucial for tracking methane and identifying cost-effective mitigation options.

From 2010 onward, Germany's approach shifted from isolated sector policies to a more integrated climate framework that implicitly covered methane. The Climate Action Programme 2020 (2014) and the Climate Action Plan 2050 (2016) set out Germany's basic GHG reduction pathway and sector strategies.^[80] These programmes mainly consolidated existing progress and played a supporting role.

Comprehensive approach (2019-present): global pledges and EU alignment

The Federal Climate Action Act (Klimaschutzgesetz, KSG),^[81] adopted in 2019, enshrined Germany's climate action and sectoral GHG targets in law. While it does not explicitly regulate methane emissions as

^[77] German Environment Agency, 'Methane, the underestimated greenhouse gas'

^[78] German Environment Agency, 'European Methane Regulation'

^[79] German Environment Agency, 'National Inventory Report for the German Greenhouse Gas Inventory 1990-2007'

^[80] Die Bundesregierung, 'Neues Klimaschutzgesetz geplant'

^[81] Federal Ministry of Justice, 'The Federal Climate Action Act'

a standalone category, it covers all GHG emissions in CO₂-equivalents (CO₂eq), in line with international reporting standards set by the IPCC and the EU. Consequently, while methane is included in national GHG inventories and sectoral emission budgets, it is not subject to specific reduction targets or dedicated measures within the law itself. The KSG sets binding annual emission ceilings for key sectors such as energy, buildings, transport, industry, agriculture, and waste management, without disaggregating targets by individual gases like methane.

After 2020, Germany's methane policy moved closer to the EU's comprehensive approach, driven by the European Green Deal, the EU Methane Strategy and International Pledges. The EU's GHG emissions reduction and climate neutrality goals frame Germany's national targets and sector pathways. Moreover, Germany also committed, as part of the Global Methane Pledge, to reduce methane emissions by 30% by 2030, compared to 2020 levels, at the COP26 of the UNFCCC.^[82]

MRV systems in the EU and Germany: from inventory to regulatory tool

In the EU and Germany, methane MRV systems have evolved alongside policy frameworks and are increasingly integrated into the implementation of those policies. While initially developed to support national greenhouse gas inventories, more recent developments, particularly in the energy sector, have introduced more explicit MRV

requirements within regulatory frameworks. As a result, MRV systems are not only used for reporting purposes, but also play a role in supporting compliance and shaping how methane mitigation policies are applied in practice.

At EU-level, methane MRV is built on a clear division of responsibilities: the European Commission proposes legislation, adopts implementing and delegated acts and provides tools and guidance. Day-to-day implementation, data collection, verification, and enforcement are carried out by national competent authorities and accredited verifiers.

EU-wide GHG inventories remain the backbone of methane MRV across all sectors. The European Environment Agency (EEA) compiles and submits the annual EU inventory to the UNFCCC using the IPCC 2006 Guidelines and the 2019 Refinement, with methane estimates reported for energy, agriculture, waste and other sources.^[83]

The EU has moved beyond an inventory-only approach by introducing measurement-based regulatory systems for fossil energy, while similar advances remain limited in other sectors. Atmospheric observation networks and satellite-based detection systems are emerging as complementary tools but are not yet fully integrated into regulatory inventories.^{[84][85]}

Germany's methane MRV system is among the most advanced in the EU. The German Environment Agency (Umweltbundesamt, UBA) publishes a detailed National Inventory Report (NIR) annually, reporting methane emissions across all IPCC sectors using Tier 2 and Tier 3 methodologies for the main methane-emitting categories.^[86]

^[82] German Environment Agency, 'Methane, the underestimated greenhouse gas'

^[83] EEA, 'Annual European Union greenhouse gas inventory 1990–2023 and inventory document 2025'

^[84] European Commission, 'Integrated Carbon Observation System'

^[85] ICOS, 'Tracking methane emissions: Making the invisible visible'

^[86] German Environment Agency, 'Submission under the United Nations Framework Convention 2025'

The legal basis for the use and processing of the German emissions data submitted under the UNFCCC is an inter-ministerial agreement between the seven ministries involved, tracing back to the State Secretaries' decision of June 2007 on the "Basic Paper on the National System for Emissions Reporting", which is referenced in later UBA publications.^[87] This agreement sets out the roles, resources and responsibilities for complying with UNFCCC national reporting obligations and specifies what data may be used for the reports. Because this agreement does not have the force of law, it remains an administrative rather than statutory basis and could in principle be altered or withdrawn through political decision. This creates a potential risk to institutional continuity in the domestic MRV process. At the same time, this setup has practical advantages, because it allows flexibility when new data sources need to be considered, for example to comply with new EU directives.^[88] While not unique in the EU, it is a notable example of a formalised coordination mechanism that combines reporting flexibility with administrative continuity.

Sectoral application of policy instruments

Regulation of methane emissions in the EU and Germany is based on EU-wide legislation, its national implementation and complementary domestic policies. This creates a mix of direct methane regulation in some sectors and indirect coverage through broader environmental and climate legislation in others. At EU level, binding legislation sets common objectives and minimum standards, while Member States retain flexibility in how these rules are implemented and strengthened. Germany has used this space to introduce, in some cases, earlier or more ambitious measures than the EU minimum requirements.

The interaction between regulatory frameworks, MRV systems and economic instruments differs across sectors, depending on the nature of emissions sources, available technologies and existing policy frameworks. In some areas, policy instruments are

relatively well developed and aligned, enabling more targeted and enforceable methane mitigation. In others, policy approaches remain more indirect, rely on broader frameworks or are constrained by weaker data systems and incentives.

INFO BOX Integrated Greenhouse Gas Monitoring System for Germany – ITMS

The Federal Ministry of Research, Technology and Space (BMFTR) is funding the development of an independent 'Integrated Greenhouse Gas Monitoring System for Germany – ITMS' since December 2021.^[89] ITMS is designed as a cross-sectoral system covering all major GHG, combining increasingly powerful atmospheric observations and measurements from ground stations, aircraft and satellites with high spatio-temporal

resolution bottom-up flux modelling and high-resolution atmospheric modelling for monitoring and documenting GHG sources and sinks.^[90] This positions Germany among the frontrunners in building the kind of multi-scale, top-down/bottom-up integration system that characterises the latest phase of methane MRV evolution, even though ITMS is still in development and not yet fully embedded in routine regulatory practice.

^[87] German Environment Agency, 'German Informative Inventory Report – Chapter 1.2 – Institutional Arrangements'

^[88] GIZ, 'A brief history of the German national reporting system on climate change'

^[89] FONA, 'Integrated Greenhouse Gas Monitoring System for Germany – ITMS'

^[90] FONA, 'Integrated Greenhouse Gas Monitoring System for Germany – Overall Concept'

Agriculture sector

The agricultural sector presents unique challenges for methane mitigation due to diffuse emission sources and complex biological processes. Unlike the energy sector, where technological solutions and regulatory enforcement are more straightforward, agricultural methane reduction requires balancing climate objectives with food security, farmer livelihoods, and rural development priorities.

Regulatory framework

Although agriculture is the largest source of methane emissions in the EU, there are no EU-wide regulations that directly and comprehensively target agricultural methane. Instead, methane is only partially covered under broader GHG and pollution frameworks and other sector regulations.

Methane emissions are addressed to a limited extent by the Industrial Emissions Directive (Directive 2010/75/EU), which regulates pollution from industrial installations, including intensive livestock farms. The directive imposes requirements related to methane emissions to large poultry and pig farms with over 300 livestock units, while cattle farms are currently exempt from these regulations. As a result, the directive only covers 3% of the total methane emissions. Including cattle farms would increase the potential coverage to approximately 43%. However, the EU Commission's proposal to extend the directive to cattle farms has not been adopted to date.^[91]

Other regulatory frameworks affect methane emissions only indirectly.

Agriculture is included among the non-Emissions Trading System (non-ETS)

sectors covered by the Effort Sharing Regulation (ESR), which sets binding national targets for overall emissions in these sectors. Under the ESR, Germany is required to reduce GHG emissions in non-ETS sectors by 50% by 2030 compared to 2005 levels. While agricultural methane emissions fall within this category, the regulation does not set methane-specific targets or measures, focusing instead on GHG limits.^[92]

Within the European Green Deal, the Farm to Fork Strategy has not introduced direct measures regarding agricultural methane. However, it aims, amongst other targets, to reach 25% organic farming by 2030, which would lower enteric methane intensity. Further, the objective to reduce fertiliser usage by at least 20% by 2030 would also have indirect benefits regarding methane emissions.^[93]

The Common Agricultural Policy (CAP) is EU's central policy instrument for the agriculture sector and has incorporated a variety of operational objectives addressing environmental issues, including climate change mitigation and adaptation, since 2014. However, the effectiveness of current approaches is constrained by the voluntary nature of many measures and the complexity of implementing them across diverse agricultural systems. In 2022, the Institute for European Environmental Policy (IEEP), Climate Action Network (CAN) and the German Environment Agency (UBA) criticised the limited potential impact of climate protection measures under CAP.^[94]

Germany does not have specific legislation or regulations targeting methane emissions exclusively in agriculture. Instead, broader frameworks and voluntary incentives indirectly address methane. The Federal Climate Protection Act (KSG 2019/2021)

^[91] Oeko-Institut, 'EU 2040 Climate Target: Contributions of the agriculture sector'

^[92] European Commission, 'Effort sharing 2021-2030: targets and flexibilities'

^[93] European Commission, 'From Farm to Fork: Our food, our health, our planet, our future – The European Green Deal'

^[94] Oeko-Institut, 'EU 2040 Climate Target: Contributions of the agriculture sector'

is the overarching law that originally set a sectoral target for agriculture including all GHGs (56 Mt CO₂eq by 2030).^[95] Since the 2024 amendment to the KSG, sectoral annual limits are no longer legally binding in same way. Due to the KSG's adjustment mechanism, the indicative 2030 emissions budget for agriculture has been revised upward to about 60.1 Mt CO₂eq. In 2025, 60.8 Mt CO₂eq were reported by the UBA.^[96]

As member of the EU, obliged to provide a Strategic Plan under the CAP, Germany's current one (2023) does not prioritise the reduction of GHG emissions. The reduction of methane is not addressed by the enhanced conditionality nor the eco-schemes, which altogether have a minor focus on climate protection.^[97]

MRV systems and data requirements

Across the EU, the current MRV framework for the agriculture sector is set by the national emission reduction target in the EU's ESR. However, there are currently no specific EU-wide MRV requirements for individual farms to measure and report their methane emissions. Instead, emissions are estimated at national level using IPCC guidelines and reported in national GHG inventories. Beyond the national inventory, voluntary schemes dominate.

In the EU and Germany, national inventories for enteric fermentation and manure management follow IPCC Guidelines, mainly using livestock population statistics with

Tier 1 or Tier 2 emission factors. Germany applies country-specific Tier 2 factors for key cattle categories based on detailed herd and feeding data.

Advanced measurement approaches such as feed-intake monitoring, respiration chambers, tracer techniques, herd-level atmospheric measurements and genetic information are used mainly in research and pilot projects in the two jurisdictions and inform improvements to Tier 2 factors rather than routine MRV. Tier 2 or 3 approaches with facility-specific data are feasible for larger intensive operations but rarely implemented for small farms.

INFO BOX

Technical measures for abating enteric methane emissions^[98]

Technical measures for abating enteric methane emissions can be focused on management, nutrition, breeding and rumen manipulation. From a climate perspective, especially breeding and rumen manipulation are of interest as they reduce absolute emissions per animal.

- Feed Additives or rumen-manipulation by impeding enzymes that are affecting the methanogenic process, represent the most promising near-term mitigation options. The EU has approved 3-nitrooxypropanol (3-NOP) supplementation as safe substance with an established efficacy via the European Food Safety Authority (EFSA). There is need for more knowledge about the long-term effects of feed additives and external factors affecting their efficacy. Also, frequent dosing of livestock is required for 3-NOP and poses a feasibility challenge as of now.
- Breeding and Genetic Programmes offer long-term mitigation potential by selecting animals with lower methane intensity per unit of production.

^[95] Bundesministerium der Justiz und für Verbraucherschutz, 'Bundes-Klimaschutzgesetz (KSG)'

^[96] German Environment Agency, 'Klimaschutz in der Landwirtschaft'

^[97] Institute for European Environmental Policy, 'Environment and climate assessment of Germany's CAP Strategic Plan'

^[98] Lund University, 'Climate or biodiversity? Agricultural policy for reducing enteric methane emissions while preserving species-rich grasslands'

TABLE 5: Tier-Level Comparison of Agricultural Methane Inventory Methods in the EU, Germany and China

	EU^[99]	Germany^[100]	China^[101]
Enteric fermentation	99.9% Tier 2 or 3 for cattle CH ₄ , 82.8% and 63.8% Tier 2 or 3 for sheep and other livestock CH ₄	Tier 1, 2 and 3 (Tier 2 and 3 for cattle, Tier 1 for sheep and other livestock)	Tier 1 and 2
Manure management	99.8% Tier 2 or 3	Tier 2	Tier 1 and 2
Rice cultivation	8/27 countries	Not occurring	Tier 2 and 3
Field burning of agricultural residues	13/27 countries	Not occurring	Tier 1

The limitations of current MRV approaches are reflected in the tier levels applied in EU, Germany and China, as shown in Table 5.

Economic instruments

At EU level, the CAP is also the main incentive instrument shaping farm decision, including those affecting methane. It channels support through direct payments, eco-schemes and agri-environment-climate

measures that can, in principle, encourage methane-reducing practices.^[102]

As each EU Member State has its own Strategic Plan under the CAP, interventions and measures vary. For example, less than half of the Strategic Plans include actions to reduce methane or ammonia emissions from livestock. Only seven Member States have designed eco-schemes that **address livestock emissions**. These schemes include practices to ensure outdoor grazing,

INFO BOX Eco-schemes and agri-environment-climate measures under the CAP^[102]

Feature	Eco-schemes	Agri-environment-climate measures (AECMs)
CAP pillar	Pillar I (Direct Payments)	Pillar II (Rural Development)
Participation	Voluntary	Voluntary
Payment	Annual payment for eligible environmental/climate practices	Multi-year payment compensating for additional costs and income foregone
Commitment	Typically one year (renewable annually)	Usually 5–7 years
Purpose	Incentivize broad uptake of sustainable practices	Support longer-term, targeted environmental and climate management

^[99] UNFCCC, 'European Union. 2023 National Inventory Report'

^[100] UNFCCC, 'National Inventory Report for the German GHG Inventory 1990-2021'

^[101] UNFCCC, 'The People's Republic of China Fourth Biennial Update Report on Climate Change'

^[102] European Parliament, 'Regulation (EU) 2021/2115 of the European Parliament and of the Council of 2 December 2021 establishing rules on support for strategic plans to be drawn up by Member States under the common agricultural policy (CAP Strategic Plans)'

adaptation of feed management or the use of feed additives to reduce emissions. In addition, few agri-environment-climate interventions address livestock emissions through measures such as genetic improvement of cows, improved feeding and, in some cases, livestock reduction.^[103]

In Germany, the total CAP budget for the period of 2023 to 2027 is about EUR 36 billion. Measures aiming at climate change mitigation receive about 1.3% of the total budget. Within its seven eco-schemes, only one is directly addressing climate change mitigation and adaptation.^[104] This means that while CAP payments could act as a key economic instrument for methane mitigation, they are currently only marginally used for this purpose.

Germany's biogas sector illustrates how energy-policy instruments can strongly influence agricultural methane emissions. The EEG introduced guaranteed feed-in tariffs for a period of 20 years and priority access to the electricity grid for renewable electricity. This triggered rapid expansion of agricultural biogas plants. These incentives encouraged farmers to invest in plants that capture methane from livestock manure and other organic residues and use it to generate electricity and heat, thereby reducing uncontrolled methane emission from manure storage.^[105]

This support model, however, also created long-term dependence on fixed feed-in tariffs. As guaranteed electricity prices are gradually phased out over the coming years, combined with broader issues in the agricultural sector, there are concerns that up to one third of Germany's nearly

9,000 existing biogas plants could cease operations by 2030. Although the expansion of biogas has been limited since 2014, recent years have seen renewed growth driven by support for biomethane grid injection. Yet, the biomethane pathway, which is also promoted at EU level, is only feasible for larger plants.^[106] Overall, biogas-related tariffs are central economic instruments for methane mitigation in German agriculture, although their future contribution to mitigation will depend on how EEG and post-EEG support is implemented.

In addition to CAP payments and energy-sector tariffs, various investment support schemes influence methane-relevant decisions at farm level. In Germany, Agricultural Investment Promotion Programs (Agrarinvestitionsförderungsprogramme), run by each German federal state individually,^[107] provide grants for upgrading stables, manure management and other infrastructure. When these programmes are linked to improved livestock housing conditions, better ventilation and modern manure storage systems, they can indirectly support methane reductions from livestock and manure management.

Product-related incentives, such as the Animal Husbandry Labelling Law (Tierhaltungskennzeichnungsgesetz) for pigs,^[108] can also drive market demand for higher animal welfare products, which may coincide with lower stocking densities and improved manure handling. While these instruments are not designed as methane policies, they operate as incentives that can contribute to lower emissions if coupled with appropriate technical conditions and support.

^[103] European Commission, 'Approved 28 CAP Strategic Plans (2023–2027) – Summary overview for 27 Member States'

^[104] Institute for European Environmental Policy, 'Environment and climate assessment of Germany's CAP Strategic Plan'

^[105] IAMO, 'Effects of the German Renewable Energy Act on structural change in agriculture – The case of biogas'

^[106] IEA Bioenergy, 'Implementation of bioenergy in Germany – 2024 update'

^[107] Landwirtschaftskammer NRW, 'Agrarinvestitionsförderungsprogramm 2023 bis 2027'

^[108] Bundesgesetzblatt, 'Tierhaltungskennzeichnungsgesetz – TierHaltKennzG'

Sectoral synthesis

The experience of the EU and Germany highlights several important lessons for agricultural methane mitigation. Methane mitigation in agriculture is primarily driven by broader sectoral policies rather than methane-specific regulation. Voluntary and incentive-based approaches dominate, although their effectiveness is often limited by low uptake and weak targeting. MRV systems remain largely inventory-based,

with limited use of measurement-based approaches at farm level. While technical mitigation options exist, their scalability is constrained by economic, operational and structural factors. Structural changes in the agricultural sector, such as shifts in herd size, production systems or farm specialisation, can contribute to methane emission reductions but they usually depend on broader economic and sectoral developments and therefore cannot be achieved by policy instruments alone.

TABLE 6: Agricultural Sector Methane Policy Instruments Comparison

	EU Approach	Germany Approach	China Approach
Regulatory Framework	Indirect regulation via Common Agricultural Policy (CAP) 2023–2027 with eco-schemes and conditionality; limited direct methane targets.	Federal Climate Action Plan 2050: 31–34% agricultural GHG reduction target by 2030 (from 1990 baseline); indirect regulation via EEG, Indirect support through federal programme for animal welfare-oriented conversion incl. livestock density reduction policies, animal husbandry labelling system, etc.	Methane Emission Control Action Plan (2023), setting objectives and sectoral measures for livestock manure utilisation, enteric fermentation and methane emissions from rice cultivation; implementation through broader agricultural, rural-development and resource-efficiency policies.
MRV and Data Requirements	Indirect and inventory-oriented MRV; no farm-level methane reporting obligation; use of tiers 2 or 3 methodologies for cattle in many Member States but simpler methods for other sources.	Follows EU's inventory logic, with more detailed country-specific tier 2/3 methods for cattle; no distinct farm-level MRV regime.	National inventory methods using mainly Tier 2 approaches for livestock and the Tier 3 CH4MOD model for rice cultivation; advanced livestock measurement approaches used mainly in research and pilot projects.
Economic Instruments	Member State-specific CAP direct payments conditional on environmental compliance; eco-schemes provide enhanced payments for climate-friendly practices.	Indirect support through EUR 1 billion animal welfare transformation fund; EEG biogas support; national climate funding for on-farm mitigation.	Financial support through broader rural-development and environmental programmes for agricultural biogas, improved rice cultivation and resource-efficient farming practices.

Energy sector

The energy sector's methane emissions are caused primarily from coal mining, oil, and natural gas operations. Policies in the EU and Germany have focused on reducing fugitive emissions, improving the integrity of pipelines, wells, and other energy infrastructure, and promoting methane capture and utilisation.

Regulatory framework

In the EU, the EU Methane Regulation (2024/1787) establishes a comprehensive legal framework to monitor, report, verify and reduce methane emissions from the oil, gas, and coal sectors, with binding rules for methane measurement, leak detection and repair, restrictions on venting and flaring and obligations relating to imported fossil fuels.

Key Regulations include:^[109]

LDAR Programmes

- The regulation mandates comprehensive LDAR programmes for oil and gas operations, including production sites, processing plants, transmission and distribution pipelines, underground gas storage and LNG terminals, to minimise methane emissions through conducting regular LDAR surveys to detect leaks and repair them.
- LDAR surveys must be carried out at prescribed minimum frequencies for different types of components and facilities, and detected leaks must be repaired within short, defined deadlines, with limited scope for justified delays and mandatory documentation of any postponed repairs.

Venting and Flaring Restrictions

- The regulation prohibits venting of methane from oil and gas operations, except in emergencies or when strictly necessary,

and only if flaring is not technically feasible or poses safety risks. Routine flaring is also prohibited under the regulation. These restrictions ensure that operational emissions from maintenance, emergencies, and processing are minimised.

- Venting methane from drainage stations of active underground coal mines is prohibited, subject to limited exemptions (e.g. where necessary for safety or in emergency situations). For closed and abandoned underground coal mines, the prohibition applies progressively in accordance with timelines set by the Regulation.
- For thermal coal mine operators, venting methane through ventilation shafts emitting more than 5 tonnes CH₄ per kilotonne of coal mined is prohibited from 2027. This limit will be further reduced to 3 tonnes CH₄ per kilotonne by 2031.

Mandatory MRV

- Operators of oil, gas, and coal facilities, including production, processing, transmission and distribution infrastructure, underground gas storage and LNG terminals, must quantify and verify their methane emissions at both source and site levels with annual reporting of verified emissions, LDAR activities, venting, and flaring events. The annual methane emissions reports are verified by accredited independent third-party verifiers.
- Operators of oil, gas and coal facilities are required to investigate methane super-emitting events identified through on-site monitoring or external detection mechanisms, report the findings to the competent authorities, and take appropriate corrective measures to minimise emissions where such events are confirmed.

- Operators must also monitor and report emissions from inactive coal mines, establish publicly accessible inventories of closed

^[109] The European Union, 'Reducing methane emissions in the energy sector'

or abandoned underground coal mines (including mines whose operations ceased up to 70 years ago), and install measuring equipment in such mines to measure and report source level emissions.

- Underground coal mines are required to implement continuous and direct measurements and quantification of methane emissions from all drainage stations and ventilation shafts.
- Surface mines must establish deposit-specific emissions factors on a quarterly basis.
- Post-mining emissions factors must be updated annually and based on deposit-specific coal samples.

Import Standards

- From 2027, importers of crude oil, natural gas, and coal must provide information on methane emissions associated with their supply chains. The Regulation provides for progressively strengthened transparency and reporting requirements and enables the introduction of methane-intensity performance standards for imports from 2030.

While the Regulation lays out a harmonised framework for all Member States, its implementation relies on national-level policies and complementary legislation.

In Germany, this EU framework interacts with domestic measures such as the Coal Phase-out Act (Kohleausstiegsgesetz) adopted in July 2020. The Act mandates the gradual reduction and eventual phase-out of hard coal and lignite power generation,

with the objective of ensuring a socially acceptable and economically manageable transition.^[110]

INFO BOX

Reduction and phasing-out schedule of Germany's Coal Phase-out Act

- Reach 15 GW of hard coal (anthracite) and 15 GW of lignite power generation capacity in 2022.
- Reach 8 GW of hard coal (anthracite) and 9 GW of lignite power generation capacity in 2030.
- The remainder must be completely decommissioned by 2038.

Although the Act sets a clear timeline to end coal-fired power generation by 2038, Germany missed the 2022 interim target of reducing coal capacity. The total coal capacity was still about 37 GW in total at the end of 2022 and had only declined to about 30.2 GW by the end of 2025.^[111] The phase-out plans show that aligning ambitious targets with real-world infrastructure build-out of replacement capacity and grid infrastructure is complex and requires adaptive and long-term planning.^[112]

MRV systems and data requirements

The energy sector faces the most comprehensive MRV obligations globally, with mandatory reporting requirements in major jurisdictions and increasingly sophisticated verification standards.

The EU Methane Regulation, as seen above, obliges fossil energy infrastructure operators, including oil, gas, and coal, to regularly measure methane emissions and submit detailed annual emission reports to national authorities.^[113]

^[110] The Federal Government of Germany, 'The Coal Phase-out Act' (Kohleausstiegsgesetz)

^[111] Energy Charts, 'Anlagen zur Stromerzeugung und -speicherung in Deutschland'

^[112] Clean Energy Wire, '2030 coal exit in western Germany increasingly unlikely given gas power plant lag – media report (2026)'

^[113] UBA, 'European Methane Regulation'

The regulation differentiates obligations by the type of facility, its methane emission potential, and the applicable measurement methodology. Facilities with higher methane emission potential (such as major gas compressor stations, underground coal mines, or liquefied natural gas (LNG) terminals) are required to install continuous measurement equipment. Smaller installations may implement periodic source-level measurements, or calculation-based methods aligned with Oil & Gas Methane Partnership 2.0 standards.^[114]

The first source-level reporting was due in February 2026 (or 2027 for non-operated assets) covering 2025 emissions. The following year and annually thereafter, the report must also include measurements of site-level methane emissions and compare them with the sum of methane emissions quantified at source (for each component) within the site.^[115]

INFO BOX

Oil & Gas Methane Partnership 2.0^[116]

The OGMP 2.0 is the flagship oil and gas reporting and mitigation initiative of the UNEP. It is widely regarded as the gold standard for methane emissions reporting. It is a voluntary key industry-led initiative in the energy sector on measuring and reporting methane emissions, created in 2014. The OGMP's work on developing standards and methodologies involves governments, civil society and business. To date, over 115 companies, with assets in more than 60 countries on five continents, representing over 35% of the world's oil and gas production and over 70% of LNG flows have become members of UNEP's OGMP 2.0. The OGMP 2.0 framework is the latest iteration of a dynamic methane emissions standard and can provide a suitable basis for methane emissions standards, based on sound scientific standards. The EU Methane Regulation builds on the relevant parts of the OGMP 2.0 framework.

The EU Methane Regulation also requires independent third-party verification for all major facilities, with accredited verifiers conducting annual audits of emission data and monitoring systems. The process is modelled on experience from the EU ETS, where third-party verification of GHG data has long been mandatory and is enforced through national accreditation bodies and cross-border mutual recognition of (certified) verifiers.

From 2027 onwards, the EU will progressively require importers of oil, gas and coal first to meet EU equivalent methane MRV standards, then to report methane intensity from 2028, and, for contracts from August 2030, to comply with a maximum upstream methane intensity threshold set by the Commission.^[117]

Germany is currently preparing to implement the EU Methane Regulation's facility-level reporting, verification and monitoring requirements, which will become fully operational for domestic fossil-energy infrastructure over the 2025-2027 period.^[118]

However, these new facility-level MRV obligations operate alongside the existing greenhouse gas inventory reporting framework under the UNFCCC, where Member States apply different IPCC tier levels for energy-related methane emissions. Reporting at tier 1 is still very common in several Member States for methane emissions from coal, gas and oil.^[119] The adequacy of emission factors can also pose a challenge. A recent analysis by Ember highlighted that Germany's

^[114] European Union, 'Regulation (EU) 2024/1787 of the European Parliament and of the Council of 13 June 2024, on the reduction of methane emissions in the energy sector and amending Regulation (EU) 2019/942'

^[115] Gleiss Lutz, 'First EU-wide methane regulation'

^[116] European Union, 'Regulation (EU) 2024/1787 of the European Parliament and of the Council of 13 June 2024, on the reduction of methane emissions in the energy sector and amending Regulation (EU) 2019/942'

^[117] European Commission, 'Methane emissions'

^[118] German Environment Agency, 'European Methane Regulation'

^[119] European Union, 'Regulation (EU) 2024/1787 of the European Parliament and of the Council of 13 June 2024, on the reduction of methane emissions in the energy sector and amending Regulation (EU) 2019/942'

coal mine methane emission factor for hard coal underground mining is outdated and may significantly underestimate actual emissions (by a factor of 28 to 220 according to Ember estimates).^[120]

Differences in MRV maturity across jurisdictions are reflected in the tier levels applied to energy-related methane inventories. As shown in Table 7, Germany relies predominantly on higher tier (tier 2 or 3) methodologies, indicating relatively detailed and accurate emission quantification. The EU average also reflects extensive use of higher-tier methods, although methodological differences remain across Member States. In contrast, China continues to employ a mix of Tier 1, Tier 2 and Tier 3 approaches, suggesting greater variability in inventory accuracy and a higher reliance on default emission factors for some source categories.

Economic instruments

The EU does not currently have a dedicated, broad-based economic incentive scheme for methane emission reduction in the energy sector. Discussions on the introduction of methane pricing through the EU Emissions

Trading System (EU ETS) or the Carbon Border Adjustment Mechanism (CBAM) are ongoing.^[124] Instead, policy relies mainly on regulatory obligations under the EU Methane Regulation which requires Member States to establish a system of incentives, including fees, charges or penalties, to ensure compliance. The fines can reach up to 20% of the annual income or turnover of the preceding business or calendar year of the Member State.^[125]

The regulation is complemented by targeted funding initiatives such as the EUR 175 million Methane Finance Sprint announced at COP28, which supports methane mitigation efforts and partnerships, especially in the energy sector.^[126]

In Germany, several economic instruments indirectly, but materially, affect methane emissions by accelerating the phase-out of coal and incentivising mine-gas utilisation. In particular,

- The Government has introduced a tendering system for the decommissioning of hard coal-fired power plants, with higher financial compensation provided the earlier the plant is decommissioned.

TABLE 7: Tier-Level Comparison of Selected Energy-Related Methane Inventory Methods in the EU, Germany and China

	EU ^[121]	Germany ^[122]	China ^[123]
Solid fuels – coal mining and handling	71% Tier 2 or 3	Tier 2 and 3	Tier 1, 2 and 3
Oil and natural gas systems	39% Tier 2 or 3 for oil operation, 72% Tier 2 or 3 for natural gas operation	Oil operation: Tier 1 and 2, Natural gas operation: Tier 2 and 3	Tier 1 and 3

^[120] Ember, ‘Urgency to update Germany’s coal mine methane emission factor’

^[121] UNFCCC, ‘European Union. 2023 National Inventory Report’

^[122] UNFCCC, ‘Germany. 2023 National Inventory Report’

^[123] UNFCCC, ‘The People’s Republic of China Fourth Biennial Update Report on Climate Change’

^[124] Ecologic, ‘Pricing methane emissions from the energy sector’

^[125] The European Union, ‘Regulation (EU) 2024/1787 on the reduction of methane emissions in the energy sector and amending Regulation (EU) 2019/942’

^[126] European Commission, ‘EU steps up efforts to abate methane emissions with partners at COP29’

- To further accelerate the phase-out of lignite-fired power plants, the German Government has also committed to cover a total of EUR 4.35 billion in payments to utilities for the country's plant operators for lost profits due to early closures.^[127]

The EEG is another key economic instrument for the energy sector. First introduced in 2000 and regularly amended, its main motivation was to incentivise and accelerate renewable energy deployment in Germany in a cost-efficient manner. Through feed-in tariffs guaranteed over a period of 20 years, it has also been instrumental in incentivising methane capture from multiple sources, including coal mine gas, and related investment.^[128]

Coal mine methane, despite not being renewable, is recognised as an eligible energy source by the legislation, designated as 'EEG electricity' under the EEG framework due to its climate mitigation value, and remains fully eligible for EEG payments enabled by the feed-in tariff (FIT) system established by the legislation.

When comparing the applicable feed-in tariffs provided for electricity generated from mine gas outlined in the EEG 2021 (§41)^[129] and EEG 2023 (§41),^[130] it can be noted that the tariff values have decreased over the years, thereby discouraging mining operations for power generation and aligning with Germany's coal phase-out strategy.

The EEG 2021 (§99) mandates government assessment by 2027 to determine whether continued support payments for mine gas remain necessary, aligning with the national transition strategy to halt all coal power generation by 2038 as per the Coal Phase-out Act.^[131]

Norway, while not an EU Member State, has close economic and regulatory links with the EU and plays an important role in the European oil and gas sector. It provides a relevant example of combining carbon pricing instruments. Since the early 1990s, offshore oil and gas operations have been subject to a carbon tax, while the sector has also participated in the EU ETS since 2008. Operators therefore face

both the carbon tax and the cost of EU ETS allowances, creating an economic incentive to reduce greenhouse gas emissions, including emissions from flaring and venting.^[132] The comparatively low emissions intensity of Norwegian oil and gas production indicates the potential effectiveness of this combined approach.^[133]

INFO BOX

The change in tariff values for operations generating electricity from mine gas are as follows under the EEG

- 6.54 (EEG 2021) → 5.98 (EEG 2023) cents per kilowatt-hour up to and including a rated capacity of 1 MW
- 4.17 (EEG 2021) → 3.81 (EEG 2023) cents per kilowatt-hour up to and including a rated capacity of 5 MW
- 3.69 (EEG 2021) → 3.37 (EEG 2023) cents per kilowatt-hour above a rated capacity of 5 MW

^[127] IEA, 'Act to Reduce and End Coal-Fired Power Generation'

^[128] Institute of Energy Economics at the University of Cologne, 'Medium-term forecast: around 18 billion euros in EEG funding in 2025'; European Commission, 'State Aid SA.57779 (2020/N) – Germany EEG 2021'; BMW, 'Act on the Development of Renewable Energy Sources (Renewable Energy Sources Act – RES Act 2014)'; IEA Bioenergy, 'Implementation of bioenergy in Germany – 2024 update'

^[129] The European Commission, 'Renewable Energy Sources Act – EEG 2021'

^[130] The European Commission, 'Renewable Energy Sources Act – EEG 2023'

^[131] The European Commission, 'State Aid SA.57779 (2020/N) – Germany EEG 2021'

^[132] Institute for Energy Economics and Financial Analysis, 'UK offshore flaring and venting'

^[133] Norwegian Petroleum, 'Emissions to air'

Sectoral synthesis

The experience of the EU and Germany highlights several key lessons for methane mitigation in the energy sector. Methane-specific regulatory frameworks with binding requirements can drive rapid emission reductions, supported by rigorous MRV systems, including facility-level measurement and third-party verification, which are central to effective policy implementation. Key regulatory tools include LDAR, as well as restrictions on venting and flaring and the establishment of clear operational standards.

At the same time, indirect structural policies, such as coal phase-out, can deliver substantial methane reductions alongside broader decarbonisation objectives. Economic incentives can support methane capture and utilisation but should be

designed as transitional and time-bound instruments. In this context, the EEG feed-in tariff model in Germany offers a key transferable element as it provides the long-term investment security needed to scale up mine gas capture and biogas projects. It also demonstrates the feasibility of gradually lowering support as technologies mature. At the same time, avoiding permanent subsidies is critical; Germany’s practice of mandating a government review by 2027 to reassess the continued necessity of support payments provides a sound model to ensure that incentives remain time-bound and aligned with phase-out and decarbonisation goals.

The following Table 8 summarises the key differences in regulatory frameworks, MRV systems and economic instruments across the three jurisdictions.

TABLE 8: Energy Sector Methane Policy Comparison

	EU Approach	Germany Approach	China Approach
Regulatory Framework	Binding and comprehensive: EU Methane Regulation (2024/1787) with strong focus on oil and gas, but comparatively weak in coal	National climate legislation + EU compliance: Climate Change Act with sectoral targets, integrated with EU Methane Regulation obligations.	Strategic Framework + sectoral guidelines: Methane Emission Control Action Plan (Nov 2023) as not legally binding but high-level policy directive. Mandatory technical standards in key sectors, particularly for CMM.
MRV and Data Requirements	Mandatory, standardised: Source and site-level emissions measurement, annual reporting, LDAR programmes and surveys.	Enhanced national system: Integration with EU MRV standards plus national GHG inventory protocols.	Revised statistical reporting system for CBM and CMM drainage and utilisation; measurement-based monitoring at selected coal mines, monitoring around offshore oil and gas platforms and satellite monitoring of methane-emission hotspots.
Economic Instruments	Penalties: Administrative fines up to 20% of annual turnover for non-compliance, published annually by Member States.	National measures: EEG feed-in tariffs for mine gas; Financial compensation for shut-down of hard coal and lignite-fired power plants.	CCER methodologies for low-concentration coal mine gas, ventilation air methane, associated-gas recovery and test-venting gas; access to green-finance and EOD project frameworks and revenue from methane recovery and utilisation.

Waste sector

The waste sector offers some of the most cost-effective methane mitigation opportunities, primarily through landfill gas capture and wastewater treatment improvements. Substantial methane emission reductions over the past decades were achieved with the support of policies, although methane mitigation was not the focus, but a co-benefit.

Regulatory framework

In the waste sector, EU-level legislation has created a strong framework for reducing landfill methane emissions. The Landfill Directive (1999/31/EC) requires Member States to set up a national strategy to reduce biodegradable waste going to landfills. Furthermore, it requires landfill gas collection systems for all landfills receiving biodegradable waste. Collected landfill gas must be treated and used. If energy production is not possible, the gas must be flared.

In the area of waste treatment and management, the Waste Framework Directive (WFD) constitutes the overarching legal framework at EU level. Initially adopted in 1975, it introduced the 1st Environmental Action Programme's three principles of waste management —preventive actions, control/rectification at the source and 'polluter pays' principle— and the obligation for the Member States to formally organise their national waste management system. The 1991 amendment introduced a hierarchy of waste management principles.^[134] The hierarchy includes, in order of priority: prevention, reuse, recycling, recovery and disposal.^[135]

The revised WFD from 2018 required that by the end of 2023 bio-waste is either collected separately or recycled at source, with implementation varying significantly across Member States.^[136] This version is part the EU's Circular Economy Package which increasingly emphasise organic waste diversion from landfills through composting, anaerobic digestion, and other treatment methods.^[137] A separate 2018 amendment to the Landfill Directive further strengthened these requirements by setting a target that by 2035 the amount of municipal waste landfilled should be reduced to 10% or less of the total amount of municipal waste generated.^[138]

In 2023, 11 Member States achieved the target to reduce the amount of municipal solid waste (MSW) sent to landfill to 10% or less. Several of these countries incinerated a considerable amount of this waste instead.^[139] In regard to waste recycling performance, there are large differences between countries. In 2023, the rates in the EU varied between 69% in Germany to 12% in Romania. Consequently, 18 Member States were identified as being at risk of not meeting the recycling target for 2025 set in the Waste Framework Directive (55% of MSW).^[140] This gap signals substantial unrealised potential for emission reductions.

Germany's waste policy framework has evolved progressively since the 1990s, combining regulatory measures on landfill, recycling and waste treatment. In 1993, Germany adopted the Technical Ordinance on Municipal Solid Waste (TASi), which made landfill gas capture compulsory and banned the landfilling of untreated MSW from June 2005 onward. This was followed

^[134] Duquennoi et al., 'European Union's policymaking on sustainable waste management and circularity in agroecosystems: The potential for innovative interactions between science and decision-making'

^[135] EEA, 'Methane emissions in the EU: the key to immediate action on climate change'

^[136] European Commission, 'Waste Framework Directive (WFD) - Directive (EU) 2018/851'

^[137] Duquennoi et al., 'European Union's policymaking on sustainable waste management and circularity in agroecosystems: The potential for innovative interactions between science and decision-making'

^[138] EUR-Lex, 'Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste'

^[139] EEA, 'Diversion of waste from landfill in Europe'

^[140] EEA, 'Waste recycling in Europe'

in 1996 by the Closed Substance Cycle and Waste Management Act, later amended in 2012 into the Circular Economy Law, which regulated the separation and recycling of organic waste and promoted producer responsibility.

The EU's 1999 Landfill Directive acted as a catalyst for Germany's 2001 Waste Disposal Ordinance, which provided the

foundation for the landfill ban in 2005.^[141]

As a consequence, the amount of waste landfilled decreased by 98% between 1995 and 2006. At the same time, recycling increased by 58% and composting by 14%, while incineration rose by 92%.

In 2009, the TASI, the Waste Disposal Ordinance and other landfill regulations were unified into one framework, the

INFO BOX

Landfill Management Choices ^[142]

Reduced degradable organic carbon content is the main mitigation option for reducing landfill methane emissions. This choice is normally made on a national or state regulatory level. Deviation of organic waste from landfills requires access to alternative treatment/beneficiation methods. This can include separate collection, mechanical separation, composting, anaerobic digestion and/or incineration.

Landfill gas recovery is another option. Landfill operators can influence the methane recovery efficiency and the moment when methane recovery starts by aspects such as cell size, when to install wells, what type of wells to install, when to start recovery, how to control recovery (gas quality or gas quantity), when to put or not put a capping or surface sealing layers, when to end recovery, what kind of passive treatment to realise, etc. Implementation of intermediate and final cover are the key to promote efficient gas capture. The cover type is the most significant operational factor affecting surface methane emissions. A final cover system with high fine soil content and use of geosynthetics results in the lowest fluxes. In Europe, the use of geosynthetic High Density Polyethylene (HDPE) liner is common.

Over-extraction is a method in which more gas is extracted than is actually generated. This implies that air is introduced into the waste body. In a mild form, it can increase gas recovery or re-activate gas wells.

In a more aggressive approach, it can be used to aerate landfills.

End of landfill gas recovery implies that flare and gas collection system is turned off once certain conditions are reached. E.g., in some countries in Europe, active recovery and treatment can be replaced by passive methods when methane generation drops below 25 m³ CH₄ per hour. These passive measures can usually only be reached very long after the start of operation as a landfill with an annual input of 500,000 tonnes waste per year can produce several thousand m³ CH₄ per hour.

Microbial methane oxidation can be applied for methane that is not recovered. This requires microbes in a suitable capping or cover layer.

Energy recovery is possible in various ways. Electricity can be generated with e.g. gas engines or gas turbines. Hot water can be generated with boilers and heat exchangers in flares or gas engines. An upgrade to biomethane is possible as well. Biomethane upgrade promises the highest yield but is also connected with the highest costs.

Emerging landfill technologies include leachate recirculation and landfill aeration. However, their impact on methane emissions without knowing e.g. the content of biodegradable waste is difficult to model.

^[141] Duquennoi et al., 'European Union's policymaking on sustainable waste management and circularity in agroecosystems: The potential for innovative interactions between science and decision-making'

^[142] Scharff et al., 'The Impact of Management Choices on Landfill Methane Emissions'; Lair et al., 'Enhancing landfill efficiency to drive greenhouse gas reduction: A comprehensive study on best practices and policy recommendations'

Ordinance Simplifying Landfill Law.^[143] The 2012 Circular Economy Act (KrWG) further reinforced Germany's waste hierarchy, mandating the separate collection of biowaste from all households from the beginning of 2015. This legislation directly reduced methane emissions by diverting organic material from landfills to controlled anaerobic digestion and composting, where methane is either captured for energy or minimised through aerobic processes.^[144]

In the last decade, recycling and composting increased further, while incineration slightly dropped.^[145] In 2023, Germany had with 68.7% the highest recycling rate for MSW within the EU, also exceeding the EU average of 47.7%,^[146] highlighting Germany's commitment to achieving a circular economy.

MRV systems and data requirements

The Waste Framework Directive (WFD), which provides the legal foundation for the sector at EU level, is relevant to methane emissions MRV, albeit indirectly through data foundations rather than direct measurement mandates. The WFD requires improved tracking and reporting of waste streams, particularly for biodegradable waste.^[147]

A key instrument under the WFD, also included in the Landfill Directive, is the so-called Waste Management Plan which each EU Member State is required to develop. The reporting requirements include the types, quantities and origins of waste to be recovered or disposed of, general technical requirements, special arrangements for particular wastes, and

suitable disposal sites or installations. The Waste Management Plans provide as well essential activity data for IPCC Tier 2 and 3 inventory calculations.

In addition to the WFD, mandatory GHG reporting is addressed through industrial facilities reporting systems at EU level. In 2006, the EU adopted a regulation for the establishment of a European pollutant register, the so-called European Pollutant Release and Transfer Register (E-PRTR). It requires entities to report, among other information, emissions and waste data to their respective national authorities for inclusion in the register. In 2024, the E-PRTR Regulation (EC) N°. 166/2006 was replaced by the introduction of the Industrial Emissions Portal Regulation (IEPR), with new requirements applying from the reporting year 2027. A key change concerns the link with the requirements of the Industrial Emissions Directive (IED). In the future, reporting will take place at plant level, rather than at company level, and the list of activities, from the companies subject to reporting, will be largely harmonised with the IED activities.

The IEPR will also include some activities beyond the scope of the IED, such as municipal sewage treatment plants –previously reported via the E-PRTR– as well as medium-sized combustion plants from 20 megawatts (MW) and the production of hydrogen through electrolysis.^[148] In total, the IEPR covers approximately 60,000 large industrial facilities operating in the EU. Reported emissions are measured, estimated or calculated, and industrial operators are required to report, among others, significant emissions such as methane.^[149]

^[143] Clean Air Task Force, 'What 4 countries that are successfully cutting waste methane have in common'

^[144] UBA, 'Compulsory implementation of separate collection of biowaste'

^[145] Duquennoi et al., 'European Union's policymaking on sustainable waste management and circularity in agroecosystems: The potential for innovative interactions between science and decision-making'

^[146] Eurostat, 'Recycling rate of municipal waste'

^[147] European Commission, 'Waste Framework Directive (WFD) – Directive (EU) 2018/851'

^[148] BMUV, 'Schadstoffregister'

^[149] European Commission, 'Industrial Emissions Portal Regulation (IEPR)'

At national level, methane-specific reporting requirements remain limited in the waste and wastewater sector in Germany. German law currently does not require nationwide mandatory methane reporting for municipal wastewater treatment plants. For specific industrial sectors, such as large abattoirs or dairy/food processing, GHG reporting may be required under environmental permits or the German Cleaner Production programme. In addition, the German Emission Control Act (BImSchG) and related technical instructions on air quality (TA Luft) regulate GHG emissions for waste and some industrial wastewater treatment, particularly for direct dischargers. However, these provisions primarily focus on local air quality rather than on methane-specific reporting.^[150]

methodological maturity varies across Member States, particularly for wastewater handling and biological treatment. China applies Tier 2 methodologies for solid waste disposal and wastewater handling but continues to rely on Tier 1 methods for biological treatment of solid waste, indicating that MRV development for these emerging waste treatments systems remains less advanced. Overall, the comparison suggests that MRV maturity is greatest established for landfill emissions.

Economic instruments

Economic instruments in the waste sector mainly work by making landfilling of organic waste less attractive and alternative

TABLE 9: Tier-Level Comparison of Waste Methane Inventory Methods in the EU, Germany and China

	EU ^[151]	Germany ^[152]	China ^[153]
Solid waste disposal on land	94.2% Tier 2 or 3 for managed disposal sites, 100% Tier 2 or 3 for unmanaged disposal sites (reported in 13/27 countries)	Tier 2 (no unmanaged disposal sites)	Tier 2
Biological treatment of solid waste	54% Tier 2 or 3	Tier 2	Tier 1
Waste incineration	Not a key category	NA	Tier 1 and 2
Wastewater handling	41.6% Tier 2 or 3 for domestic WW, 64.6% Tier 2 or 3 for industrial WW	Default / country-specific	Tier 2

The differences in MRV approaches across jurisdictions are reflected in the tier levels applied, as shown below. Germany applies consistently higher-tier methodologies across the waste sector, reflecting mature waste management systems and well-developed national data. For the EU,

treatments more attractive, rather than by pricing methane directly.

Landfill taxes and gate fees are the most common economic instrument across the EU and make landfilling comparatively expensive, thereby steering waste towards

^[150] German Environment Agency, ‘Methane, the underestimated greenhouse gas – Sources, effects, mitigation options’

^[151] UNFCCC, ‘European Union. 2023 National Inventory Report’

^[152] UNFCCC, ‘National Inventory Report for the German GHG Inventory 1990-2021’

^[153] UNFCCC, ‘The People’s Republic of China Fourth Biennial Update Report on Climate Change’

recycling, biological treatment and waste-to-energy. In 2021, 23 EU Member States had a landfill tax, with tax rates varying from EUR 5 to more than EUR 100 per tonne.^[154]

In addition, waste collection fees are increasingly designed to incentivise waste producers to reduce waste generation and to sort their waste, following the polluter-pays principle. This is typically implemented through pay-as-you-throw (PAYT) schemes. PAYT systems are designed in many different ways, but can be categorised in two types:

- Basic PAYT systems: Volume-based systems → collection fee based on size of the container and collection frequency; service contract that defines number or size of containers for mixed MSW
- Advanced PAYT systems: Weighing waste containers on pick-up → payment by weight of waste generated; sack-based systems → citizens buy waste sacks from municipality or service provider

The majority of EU Member States have some form of PAYT system in place for at least part of the population, usually supported by legislation.^[155]

Germany is one of the few EU Member States without a national landfill tax, due to its strict regulatory ban on landfilling of untreated municipal waste since 2005. Instead, economic incentives have focused on promoting methane capture and utilisation. In this context, the Renewable Energy Sources Act (EEG), introduced in 2000 and discussed in the energy sector chapter, also

plays a role in the waste sector. The EEG includes landfill and sewage gas, as well as biogas from organic waste, by granting guaranteed fixed feed-in tariffs for 20 years, along with guaranteed grid connection and priority dispatch. This has encouraged the utilisation of high-calorific landfill gas for power and heat generation, instead of flaring or venting, thereby reducing methane emissions at active or relatively young sites. However, the EEG incentive did not address the challenge of residual methane from old landfills with low gas flow.

To address this gap, Germany's National Climate Initiative (NCI), since 2013, has co-financed advanced post-closure measures such as landfill aeration and optimised gas capture to accelerate the stabilisation of old landfills and reduce their remaining methane emissions.^[156] NCI funding covers a wide range of climate action projects with public funding amounting to around EUR 1.35 billion, triggering total investments of over EUR 4.3 billion.^[157] Funding rates vary; for example, up to 50% (or 60% for financially weaker municipalities), is provided for optimised gas capture, under the condition that gas-capture rate increase by at least 25% or reach at least 60% of landfill gas.^[158]

In parallel, in case of non-compliance with landfill gas collection and treatment requirements under the Landfill Ordinance, sanctions are imposed as administrative offences under waste and environmental law, with German federal state (Länder)-level fine catalogues specifying penalties of up to around EUR 100,000 per infringement.^{[159][160]}

^[154] CEWEP, 'Landfill Taxes and Restrictions'

^[155] EEA, 'Economic instruments and separate collection systems – key strategies to increase recycling'

^[156] German Environment Agency, 'Unterschätztes Treibhausgas Methan'

^[157] Federal Ministry for Economic Affairs and Energy, 'What is the National Climate Initiative'

^[158] Bayerisches Landesamt für Umwelt, 'Förderprogramm Nationale KlimaschutzInitiative'

^[159] Bundesamt für Justiz, 'Landfill Ordinance (DepV)'

^[160] Landesrecht Brandenburg, 'Bußgeldkatalog des Ministeriums für Umwelt, Naturschutz und Raumordnung'

Sectoral synthesis

The experience of the EU and Germany highlights several key lessons for methane mitigation in the waste sector. Upstream waste diversion, particularly reducing biodegradable waste going to landfills, is the most effective mitigation strategy. Binding regulatory measures, such as landfill bans and mandatory gas capture, have enabled rapid and sustained emission

reductions. At the same time, methane mitigation is often achieved as a co-benefit of broader waste management and circular economy policies. Economic instruments, including landfill taxes and PAYT systems, can effectively complement regulatory measures by steering waste away from landfills. MRV systems rely largely on waste flow data and inventory methods, with limited direct methane measurement at facility level.

TABLE 10: Waste Sector Methane Policy Comparison

	EU Approach	Germany Approach	China Approach
Regulatory Framework	• Landfill Directive (1999/31/EC, amended 2018): progressive reduction of biodegradable waste to landfill, including a maximum of 10% MSW landfilled by 2035 • Waste Framework Directive establishing the waste hierarchy • Urban Wastewater Treatment Directive (91/271/EEC) requiring treatment of wastewater	• Technical Ordinance on MSW (1993) • Waste Disposal Ordinance (2001) • Landfill Ordinance / Ban on landfilling untreated MSW (in force since 2005) • Circular Economy Act (2012, amended 2020)	• ‘Zero-Waste Cities’ initiative (2018) • National solid waste classification / sorting campaign (2019) • Methane Emission Control Action Plan (2023) with voluntary guidelines; target of 60% waste utilisation rate by 2025.
MRV and Data Requirements	Indirect and inventory-oriented; Waste management plans; plant-level emission reporting for large industrial installations according IEPR.	No nationwide methane MRV. Inventory draws on detailed national statistics, monitoring requirements via permits.	Primarily Tier 1 and Tier 2 inventory methods, with limited direct or site-specific methane measurement.
Economic Instruments	Member States required to implement economic instruments to encourage waste hierarchy application (e.g. Landfill taxes and gate fees, PAYT schemes); Innovation Fund and Horizon Europe support waste-to-energy and biogas technologies.	EEG support for biogas from organic waste; National Climate Initiative funding.	Investment in waste-treatment facilities, landfill management systems and wastewater treatment, contributing indirectly to methane mitigation through improved waste handling and processing.

Chapter 4: Comparative Insights, Lessons Learned and Applicability

Building on the preceding analysis, this chapter synthesises comparative insights from China, the EU and Germany to examine how sectoral structures, MRV systems, regulatory approaches and economic instruments shape methane mitigation path-ways and implementation outcomes. Particular attention is given to the extent to which methane has evolved from a co-benefit of broader environmental and climate policies into an explicit policy objective supported by sector-specific measures, improved emissions data and targeted incentive structures.

Structural determinants of methane governance effectiveness

The comparison between China, the EU and Germany shows that methane mitigation outcomes are shaped by a combination of individual policy instruments and the degree to which monitoring, regulation and incentives work together. Where binding rules are clear and operationalised, they have translated into measurable methane emission reductions; where policies are indirect or voluntary, results have been more limited.

Concentrated emission sources in the energy sector are generally more compatible with direct regulation, facility-level monitoring and targeted technological intervention. Relatively concentrated infrastructure, commercially available abatement

technologies and increasingly mature MRV systems have enabled comparatively rapid and measurable methane reductions. This makes the energy sector particularly important for near-term methane mitigation. However, if policy development and MRV systems remain concentrated in the energy sector, as is currently the case in the EU, there is a risk of over-reliance on energy methane reductions and delayed action in more complex sectors such as agriculture and waste, which may undermine long-term mitigation pathways.

By contrast, agricultural methane emissions remain more difficult to regulate than emissions in the energy and waste sectors because they are diffuse, biologically embedded, and closely tied to farm management and production systems. In all jurisdictions examined, agricultural methane mitigation relies more heavily on incentive structures, pilot approaches and broader agricultural policy frameworks than on methane-specific regulation. As residual methane emissions become increasingly concentrated in diffuse biological sources, existing policy approaches face growing limitations, particularly where mitigation depends on changes in agricultural production systems and farm-level practices. It also suggests that demand-side measures, such as shifts in dietary patterns, product standards, and public procurement, may become increasingly relevant alongside supply-side mitigation.

The waste sector occupies an intermediate position. Effective methane mitigation has largely depended on long-term infrastructure development, landfill diversion, wastewater

treatment expansion and structural changes in waste management systems. In the EU and Germany, substantial reductions were enabled through a combination of binding landfill regulation, waste hierarchy approaches and supporting economic incentives. Remaining emissions are increasingly linked to legacy and closed landfills as well as fugitive emissions from landfill gas collection systems. The implementation of organic waste treatment infrastructure (anaerobic digestion, composting and mechanical-biological treatment) and sludge management systems require long-term investment and structural change.

Differences in MRV maturity reinforce these sectoral dynamics. Methane emissions from the energy sector are increasingly well quantified through facility-level monitoring and direct measurement approaches, while agricultural and some waste-sector emissions remain more dependent on statistical estimation methods and associated uncertainties. Measurement-based verification approaches, including satellite observations and top-down monitoring, improve inventory accuracy and support regulatory enforcement. Mitigation opportunities in sectors with less developed monitoring systems may receive less policy attention and investment support.

Economic instruments also differ significantly across sectors. In the energy sector, methane mitigation is increasingly supported through targeted financial incentives, carbon market mechanisms and commercially viable recovery technologies. By contrast, agriculture and waste continue to rely more heavily on broader subsidy schemes, pilot financing mechanisms and indirect incentives that are not specifically designed around methane mitigation objectives.

The focus on energy enables rapid and cost-effective methane reductions where technologies and governance structures are already in place. However, as relatively low-cost reductions in coal, oil and gas systems are exhausted, agriculture and

waste account for a growing share of residual methane emissions, particularly in the EU and Germany. Underdeveloped policy and MRV systems in these sectors may therefore become an increasing constraint on long-term methane mitigation.

Governance sequencing and institutional evolution

The comparison shows that methane governance in the EU, Germany and China has generally developed from inventory systems, technical measures and pilot projects towards more integrated MRV, regulatory and implementation frameworks. However, the pace, sequencing and sectoral coverage of this evolution differ significantly across jurisdictions.

Economic instruments often evolve alongside this process. Early-stage methane governance frequently relies on project-based incentives and pilot financing schemes, while more mature systems increasingly integrate methane objectives into broader carbon markets, infrastructure investment frameworks and sector-specific support mechanisms.

EU and German experience shows that early, non-methane-specific measures in waste and energy can deliver substantial methane reductions as co-benefits but eventually leave important sources and supply-chain emissions outside their reach. Over time, both jurisdictions learned that higher-tier, IPCC-consistent inventories and formal reporting systems are essential to make methane visible in policy, track sector trends and identify cost-effective mitigation options. Dedicated methane strategies become more important once relatively low-cost structural reductions had already been achieved, and remaining emissions became concentrated in technically complex or diffuse sources.

The comparison further illustrates that methane MRV systems evolve from primarily statistical reporting tools towards operational governance instruments. In the EU and Germany, methane MRV increasingly supports regulatory enforcement, facility-level accountability and investment prioritisation, particularly in the energy sector. Regulatory approaches have also become progressively more binding and measurement-based over time. In China, methane MRV systems are expanding rapidly but still focus mainly on inventory development and institutional capacity building rather than direct compliance enforcement.

The European and German experience suggests as well that methane governance often develops through broader environmental, industrial and infrastructure policies rather than through methane-specific regulation alone.

Limits of policy transferability

The comparison highlights clear limits to the direct transferability of methane mitigation policies across jurisdictions. Methane governance pathways are fundamentally shaped by sectoral structures, economic development patterns, institutional capacities and political priorities.

In China, methane mitigation continues to develop in a context where major structural drivers of emissions, particularly coal production, industrial activity, urbanisation and expanding waste generation, remain closely linked to economic development and energy security objectives. This differs substantially from the conditions under which the EU and Germany achieved major methane reductions, including declining coal production, mature waste-management infrastructure and comparatively stable agricultural systems.

As a result, policy instruments that proved effective under conditions of slower demand

growth and relatively mature infrastructure systems, as in the EU and Germany, cannot be directly replicated in rapidly developing contexts such as China without substantial adaptation. Their effectiveness depends on alignment with ongoing structural transitions rather than assumption of comparable baseline conditions.

Differences in MRV maturity further reinforce these constraints. In the EU and Germany, methane mitigation increasingly relies on established MRV systems linked to regulatory enforcement and investment decisions. This is particularly evident in the energy sector, where emissions monitoring underpins requirements for LDAR, venting and flaring reduction and methane reporting. In China, MRV development remains more closely associated with capacity building, inventory improvement and phased institutional development. While monitoring systems for coal mining are expanding relatively rapidly, MRV approaches for agriculture and waste continue to evolve alongside broader improvements in statistical systems. These differences affect the scope, enforceability and sequencing through which mitigation measures can be expanded across sectors.

Strategic implications for China

The analysis shows that China has made significant progress in establishing the institutional foundations for methane mitigation, particularly through national action plans, pilot programmes and expanding MRV capacities. However, important gaps remain in the integration and implementation of mitigation measures across sectors.

The comparison with the EU and Germany suggests that continued strengthening of methane governance in China will likely depend on further development of sector-specific MRV systems, clearer institutional responsibilities and stronger coordination between monitoring systems,

regulatory frameworks and implementation incentives. In the energy sector, this includes expanding MRV and regularly oversight to support methane abatement in coal, oil and gas operations. In the waste sector, continued investment in landfill gas recovery, organic waste treatment and modern waste-management infrastructure will be required as waste generation continues to grow. In agriculture, progress is likely to depend on improving emissions quantification and strengthening and developing incentive-based approaches that support the adoption of mitigation measures. This would also require more systematic alignment between methane mitigation objectives and economic instruments, including carbon market methodologies, green finance mechanisms and targeted financial incentives capable of supporting mitigation deployment across sectors with differing implementation conditions. Further progress will also depend on strengthening coordination between methane mitigation objectives and broader sectoral policies related to energy transition, industrial development, agricultural modernisation and urban waste management.

The comparison also suggests that the relative importance of agriculture and waste

is likely to increase over time as lower-cost reductions in coal, oil and gas systems are progressively exhausted. While the EU and Germany have already achieved substantial reductions in waste-sector methane through landfill diversion, landfill gas recovery and mature waste-management systems, future mitigation increasingly focuses on legacy landfill emissions and more challenging agricultural sources. China is likely to experience a similar transition as methane emissions from coal production decline and waste-management infrastructure continues to improve, placing greater emphasis on agricultural mitigation and long-term transformation of waste systems.

For China, a phased, sector-by-sector approach is recommended, integrating methane mitigation into wider objectives related to energy transition, circular economy development, agricultural modernisation and urban waste management. Effective implementation depends on clear technical standards, robust planning mechanisms, and pilot-driven implementation to test and refine interventions before scaling nationally. This approach balances ambition with feasibility, enabling gradual alignment of policies, MRV, and industry practices while building capacity across provinces and sectors.

Chapter 5: Policy Recommendations and Roadmap

Building on the comparative insights developed in Chapter 4, this chapter outlines policy recommendations and a phased implementation roadmap for strengthening methane mitigation in China. It identifies priority actions for strengthening methane governance and scaling mitigation measures across sectors over the short, medium and long term. The recommendations are further illustrated through province-level applications in Guangdong and Shandong to reflect differing economic and sectoral conditions.

Approach for methane mitigation in China

Methane mitigation priorities differ substantially across sectors due to varying emission profiles, governance conditions and implementation capacities. Several cross-cutting priorities require particular attention:

- Integrate methane more explicitly into the 'Dual Carbon' framework through clearer sectoral planning, quantitative benchmarks and recognition of methane as a distinct mitigation priority;
- Strengthen institutional coordination mechanisms between climate, environmental, agricultural and energy authorities to address cross-sector emission sources that require joint governance;
- Build on the Methane Emissions Control Action Plan by developing sector-specific methane requirements and near-term

implementation measures for the energy (coal, oil and gas), waste and agriculture sectors under existing laws and technical codes;

- Use the expanding CCER framework to support the development of methane MRV systems, pilot implementation and economic incentives across sectors;
- Continue collaboration with international partners, including the EU and Germany, to further support technical capacity building, MRV development and policy design;
- Use pilot regions or provinces to test integrated methane mitigation approaches under differing economic and sectoral conditions.

Strengthening methane MRV systems and data quality

Improving methane MRV systems and data quality is essential for expanding effective methane mitigation across sectors. As methane policies become more comprehensive, standardised and measurement-based approaches will be needed to improve data quality, transparency and enforcement.

Drawing on the evolution of MRV systems in the EU and Germany from inventory-centred towards more measurement-driven approaches, the following priorities appear particularly relevant for China's further development of methane MRV systems and data quality:

- Introduce facility-level reporting requirements for primary methane sources, especially in fossil energy value chains and large waste installations;
- Gradually expand the deployment of continuous monitoring systems at major facilities, enabling the detection of episodic and high-frequency emission events;
- Integrate independent third-party verification mechanisms for selected high-emitting sectors and facilities in coal mining, oil and gas, livestock, solid waste and wastewater to enhance data credibility and compliance assurance;
- Systematically combine satellite and other atmospheric observations with bottom-up inventories, using discrepancies to refine emission factors and improve consistency across spatial scales;
- Develop and roll out standardised MRV methodologies and data formats across sectors, to ensure consistency in data collection, reporting and verification and to support comparability across jurisdictions.

In addition, the establishment of a **national methane data platform** could significantly enhance data integration and accessibility. Such a platform could combine facility-level reporting, satellite data and provincial inventories, supported by digital reporting tools and automated verification processes. This would enable more transparent, consistent and policy-relevant methane data across sectors and jurisdictions.

Economic instruments

Once core regulatory frameworks and MRV systems are established, economic incentives can accelerate the adoption of methane mitigation technologies and practices without replacing compliance obligations.

The following tools could explicitly be of interest in the context of China:

- **Feed-in tariffs (FiTs):** Strengthen and scale up existing FiTs for agricultural and forestry biomass power projects by extending access to smaller-scale agricultural applications and applying FiTs in the waste sector to support landfill gas recovery, thereby delivering combined methane mitigation and energy benefits.
- **Tax breaks:** Tax incentives for investments in methane capture and utilisation technologies can reduce upfront costs and improve project viability.
- **Low-interest loans:** Many methane mitigation technologies require substantial upfront investment. Preferential financing mechanisms can improve access to capital and support broader deployment of mitigation technologies and practices.
- **Performance-tied fees:** Consider gradually introducing charges for high-emitters that exceed defined methane-intensity benchmarks, drawing on Norway's experience of combining a carbon tax with EU ETS allowance obligations to strengthen incentives to reduce methane emissions in the oil & gas sector.
- **Carbon market mechanisms** that recognise methane mitigation could be essential instruments. They encourage businesses to seek out and implement innovative methane-reduction technologies and practices.

Phased roadmap for methane mitigation

A model for phased development of methane mitigation policies in China is proposed below, highlighting the strengthening of MRV systems, regulatory frameworks and economic instruments over time.

TABLE 11: Proposed Simplified Phased Roadmap for China.

	Strategic focus	MRV systems	Regulatory frameworks	Economic instruments
Short term	Strengthening the foundations.	Improve data availability and inventory accuracy; expand pilot monitoring approaches.	Clarify and strengthen existing frameworks; begin addressing key emission sources.	Scale existing support mechanisms and pilot financial incentives.
Medium term	Expand and integrate methane mitigation across sectors.	Transition towards more standardised and measurement-based systems; improve data transparency.	Introduce more binding and sector-specific requirements; strengthen enforcement.	Expand and align economic incentives with regulatory objectives.
Long term	Achieve full system integration and sustained emission reductions.	Establish comprehensive, measurement-based MRV systems across sectors.	Fully integrate methane into climate and environmental regulation.	Develop stable, long-term incentive structures supporting structural transformation.

The roadmap reflects a transition from strengthening existing systems and closing key data gaps in the short term, towards expanding policy coverage and enforcement in the medium term and ultimately achieving full system integration and sustained emission reductions in the long term.

Short-term priorities: strengthening the foundations

Short-term priorities could focus on improving methane data, strengthening existing policy frameworks and expanding pilot implementation. This could include further consolidating the 2023 Methane Action Plan into a clearer cross-sector methane governance framework and strengthening coordination across key sectors and authorities.

Improving methane data and monitoring systems could be a central short-term priority. This includes expanding the national emission factor database and strengthening facility-level data collection, particularly in coal mining and oil and gas operations. Pilot monitoring approaches could also be expanded through greater

use of satellite-based detection and facility-level measurement technologies. Existing MRV pilot approaches in sectors such as coal, oil and gas, landfills and wastewater could progressively be standardised and integrated into more consistent national guidance and methodologies. In the energy sector, this can build on existing CCER methodologies for coal mine methane and ventilation air methane, while in agriculture and waste, pilot projects could focus on developing region-specific emission factors and improving activity data.

At the same time, existing policy frameworks could be clarified and strengthened. In the energy sector, this includes extending regulatory coverage to emerging sources such as abandoned coal mines. In oil and gas systems, early deployment of LDAR programmes can contribute to rapid emission reductions. In agriculture and waste, existing guidelines could gradually be converted into more enforceable sector-specific standards and requirements, including the introduction of methane-related requirements in environmental impact assessments and the development of sector-specific standards.

Short-term actions could also aim to scale existing economic instruments. This includes

expanding the scope of the voluntary carbon market to cover additional methane sources, reducing transaction costs for project developers and improving access to finance. In parallel, targeted support mechanisms could be strengthened, including incentives for biogas development, coal mine methane utilisation, support for alternate wetting and drying in rice cultivation, and financing mechanisms for landfill gas recovery and waste-to-energy systems, prioritising high-impact and well-monitored projects.

Pilot initiatives are particularly important at this stage, as they allow for testing integrated approaches, building institutional capacity and developing scalable MRV methodologies. Especially in consideration of the diversity of agricultural systems across provinces, pilot and demonstration projects in this sector can help identify regionally appropriate mitigation pathways while balancing methane mitigation with food security and rural development objectives.

Medium-term actions: expanding and integrating policy frameworks

Medium-term priorities could focus on expanding policy coverage, strengthening enforcement and integrating methane mitigation more fully into climate and sectoral policy frameworks.

MRV systems could evolve towards more standardised and measurement-based approaches. This includes expanding higher-tier methodologies across sectors, scaling facility-level monitoring systems and integrating remote sensing technologies into national reporting. Mandatory methane MRV requirements could progressively be introduced for major emission sources, particularly in coal mining, oil and gas systems, landfills and large wastewater installations. In parallel, verification systems could be strengthened through third-party verification and enhanced data transparency requirements.

Regulatory frameworks could become more binding and sector-specific, particularly in agriculture and waste. This includes the introduction of methane-specific emission standards, mandatory reporting requirements and compliance mechanisms for key emission sources. Over time, voluntary and pilot-based approaches could be replaced by enforceable methane emission limits and compliance requirements for key sectors, including the phased introduction of LDAR requirements, venting and flaring limits, coal mine methane utilisation requirements and landfill gas standards.

Economic incentives could increasingly support compliance with methane mitigation requirements and large-scale deployment of mitigation technologies. This includes strengthening carbon market mechanisms for methane, progressively recognising high-integrity methane mitigation activities, including coal mine methane utilisation, biogas and landfill gas recovery, and supporting large-scale deployment of methane capture and utilisation systems through targeted subsidy schemes. Risk-sharing mechanisms, such as public guarantees, can help mobilise private investment.

Long-term transformation: achieving systemic methane reduction

In the long term, methane mitigation could become a routine component of climate, environmental and sectoral governance across all major emitting sectors. Methane targets could also be more explicitly integrated into climate and air quality planning processes, supported by increasingly reliable and verified MRV data.

MRV systems could become fully measurement-based, integrating continuous monitoring technologies, satellite data and digital reporting platforms across sectors.

This will enable more accurate tracking of emissions and support ongoing policy evaluation and adjustment. Methane MRV systems could also be integrated into national reporting systems and relevant international and market-based mechanisms.

Regulatory frameworks could provide comprehensive coverage of methane emission sources, including diffuse emissions in agriculture and legacy infrastructure such as abandoned coal mines. As emissions from active coal production decline over time, increasing attention will likely be required for legacy and diffuse methane sources, which could be progressively incorporated into national methane governance frameworks and long-term monitoring systems. Methane-specific requirements could be embedded within broader environmental and climate legislation.

Mature carbon market mechanisms and long-term financing mechanisms could support large-scale methane mitigation infrastructure, including biogas systems and advanced waste-treatment facilities. In agriculture, integrated crop-livestock circular systems could provide additional mitigation opportunities by enabling the local utilisation of manure and reducing emissions associated with storage and transport.

Achieving these objectives will require continued adaptation of policy approaches to sectoral conditions, particularly in agriculture and waste, where methane emissions remain more dispersed. In these two sectors, mitigation options are more heterogeneous, and implementation must be balanced with broader objectives related to food security, rural development and continued urbanisation.

Provincial application, scaling and transferability

The phased roadmap can also be applied at provincial level, with its sequencing adapted to local emission profiles, economic structures and institutional capacity. In highly industrialised and urbanised provinces with advanced waste-management infrastructure, such as Guangdong, early priorities could include enhanced landfill-gas capture and reduced reliance on landfilling, low-emission rice cultivation practices such as alternate wetting and drying, and improved methane management in oil and gas operations. In coal- and livestock-intensive provinces, such as Shandong, priorities could include stronger implementation of coal mine methane drainage, capture and utilisation requirements, improved manure management and agricultural biogas systems, supported by strengthened provincial accounting and regulatory frameworks.

Applying the roadmap under these contrasting provincial conditions could help test and refine its MRV, regulatory and economic measures before wider replication. Lessons from such applications could inform methane-policy design in other provinces with comparable economic structures and emission profiles. In particular, approaches to strengthening MRV systems, implementing sector-specific regulatory measures and expanding economic incentives could be adapted and scaled according to regional conditions.

In this way, provincial pilot application of the roadmap could support policy learning and diffusion and contribute to the gradual integration of methane mitigation into China's broader climate-policy framework.

Annex 1: Overview of Methane Monitoring and Measurement Technologies

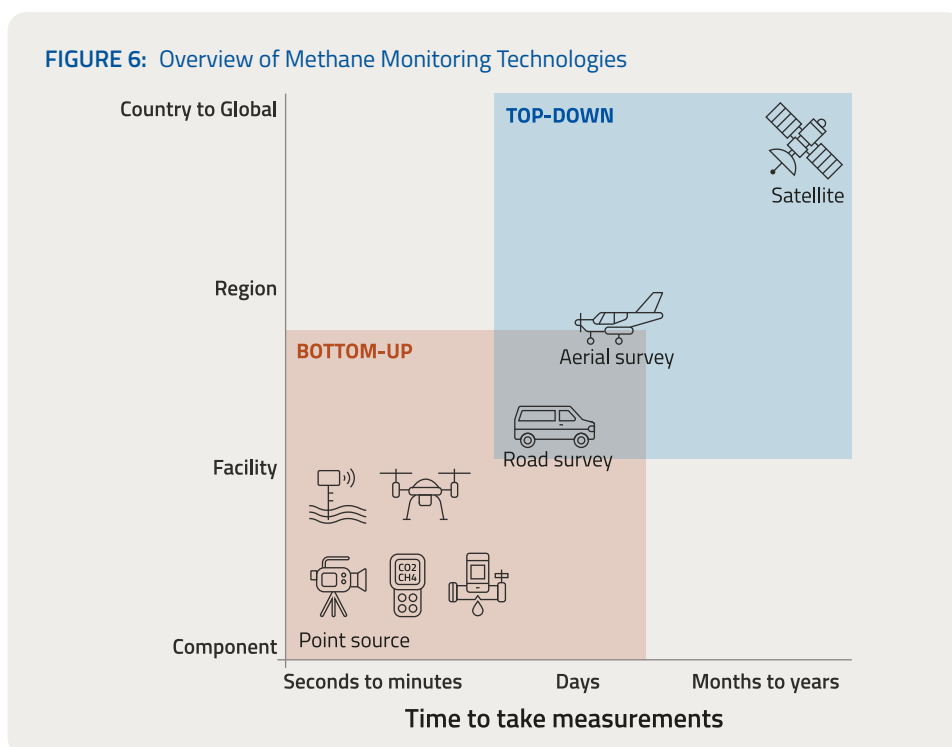
Methane MRV systems increasingly rely on a combination of complementary monitoring technologies that differ in spatial coverage, temporal resolution and operational application. These technologies support both top-down atmospheric observation approaches and bottom-up source-level monitoring and are becoming increasingly important for methane governance, regulatory compliance and emissions verification.

A spectrum of emission monitoring and measurement technologies is utilised to better monitor and manage methane emissions.

Key technologies can be categorised as follows:

- Satellite Monitoring Technologies
- Ground-based Technologies
- Aerial Surveillance Technologies

Satellite monitoring technologies are applied in top-down data collection, while ground-based technologies are commonly applied for bottom-up data collection. Aerial surveillance can be applied by both approaches. The following Figure 6^[161] shows the different monitoring technologies and their relation to area measured and time to take measurements.



[161] Imperial College London, 'MGP Guidance: Overview of Methane Monitoring Technologies'

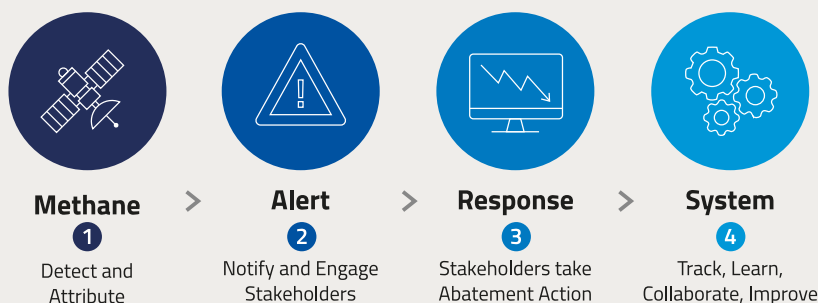
Satellite Monitoring Technologies

Methane emission satellite monitoring technology uses advanced satellite systems to detect and quantify methane emissions from various sources, mainly in the energy sector. It plays a fundamental role in monitoring compliance with environmental regulations and serves as a powerful tool for stakeholders to make informed decisions and act accordingly in the battle against climate change.

As shown in Figure 7^[162], the MARS process consists of four key components:

1. Detect and Attribute: UNEP's IMEO coordinates with the Committee on Earth Observation Satellites (CEOS) and operates with existing global mapping satellites to detect significant sources of methane globally.
2. Notify and Engage: Relevant governments and companies are alerted about large emissions events happening in or around their jurisdictions in real time, with continued engagement until further information is available.

FIGURE 7: The MARS Process



3. Stakeholders Take Abatement Action: Stakeholders are responsible for determining how best to respond to the notified emissions events and sharing their actions with MARS to pledge to environmentally responsible operations.

4. Track, Learn, Collaborate, and Improve:

The Methane Alert and Response System (MARS) is a leading example of methane emission satellite monitoring technology and is a global satellite detection and notification system launched by the International Methane Emissions Observatory (IMEO) of the UNEP. It is, amongst others, supported by the European Commission. It provides rapid, actionable and transparent satellite data on methane emissions. MARS has notified over 120 major emissions events in 2023 across 4 continents concerned stakeholders to assist with their decision-making regarding rectifying or addressing identified activities with notable methane emissions.

UNEP's IMEO persistently monitors event locations for future emissions, and data collected by the system is publicly available 45 to 75 days after detection. Collaboration between UNEP's IMEO, MARS, and its partners is key to the process, as the MARS ecosystem aims to continually learn from notified events to keep improving MARS and its impact on methane emissions monitoring and mitigation.

Although satellite monitoring has positively impacted global methane emissions detection and tracking, certain limitations exist. The following Table 12 shows the advantages and disadvantages of satellite monitoring technology.

^[162] UNEP, 'How MARS works'

TABLE 12: Advantages and Disadvantages of Satellite Monitoring Technology

Advantages	Disadvantages
• Wide coverage and ability to monitor remote and otherwise inaccessible locations • Real-time accurate data on methane emissions • Ability to detect and monitor super-emitters and emitting events of methane (i.e. emissions of 100kg of methane per hour or more) • Does not require physical access to emission sources thus reducing operational costs and risks associated with on-site inspections	• Currently limited to high emission events and to areas where satellites can take measurements • Substantial upfront investments in technology and infrastructure • Dependence on weather conditions for effective detection and monitoring • Interpreting data collected by the satellite systems requires specialised expertise which may not be readily available in all concerned organisations.

Ground-based Technologies

Ground-based methane emissions monitoring technologies use various methods and devices to detect, measure, and analyse methane emissions from various sources, such as oil and gas operations, landfills, and industrial activities.

Optical Gas Imaging Cameras: One widely utilised ground-based technology is optical

gas image (OGI) cameras, which are infrared cameras that detect and visualise methane and other hydrocarbon gas emissions. They capture infrared light and transform it into visible images by detecting the gas's thermal or spectral signature. OGI cameras are often used in the oil and gas industry to detect emissions and gas leaks that are otherwise invisible to the naked eye. ^[163]

Table 13 shows the advantages and disadvantages of optical gas imaging technology.

FIGURE 8: Optical Gas Imaging Process

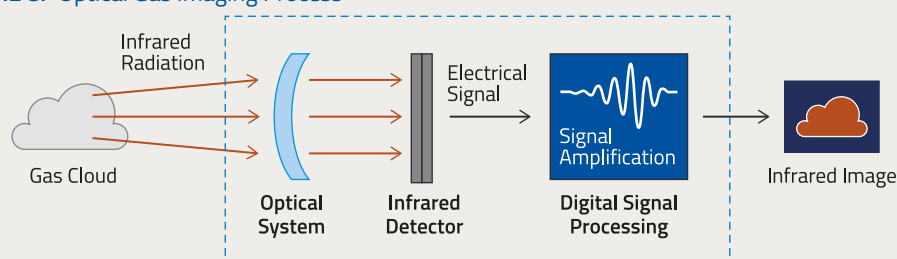


TABLE 13: Advantages and Disadvantages of Optical Gas Imaging Technology

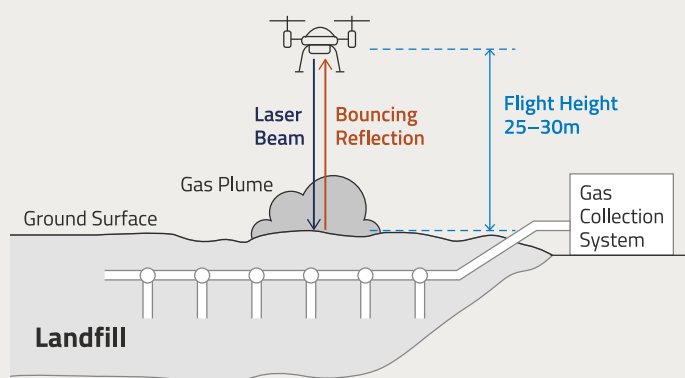
Advantages	Disadvantages
• High accuracy and real-time visualisation of emissions and leaks • Immediate leak detection • Effective for detecting large leaks and hard-to-reach areas • Non-intrusive and safe to use by operators	• Requires proximity to the source for accurate operation • Can be time consuming to survey numerous components in a facility • Requires regular calibration and maintenance • Certain OGI cameras can be rather expensive

^[163] Zhang, Mengjie & Chen, Guanghai & Lin, Peng & Daming, Dong & Leizi, Jiao. (2024), 'Gas Imaging with Uncooled Thermal Imager. *Sensors*. 24. 1327. 10.3390/s24041327'

Aerial Surveillance Technologies

Aerial surveillance technology involves using sensors or OGI cameras fitted to manned air-craft and drones to detect and monitor methane emissions from different energy sources and operations. These technologies provide higher spatial resolution than satellites and can cover larger areas than ground-based surveys in significantly shorter periods.

FIGURE 9: Drone Methane Detection Over a Landfill



and emergency response to system leaks. Drone technology has revolutionised methane emissions monitoring by offering a much more flexible, accurate, and cost-effective approach to aerial emissions monitoring. The specialised sensors often use laser-based technology such as LiDAR (Light Detection and Ranging), which collects data that can be used to construct detailed 3D models of the surveyed surfaces. The data collected by the drone is analysed using advanced analysis and modelling software to determine the sources of the emissions and quantify the volume of methane released by the operation, thus assessing the overall environmental impact.

Methane emissions monitoring by drone is commonly employed in the oil and gas industry to detect and quantify methane leaks from pipelines, wells, and processing facilities, in the waste management sector to monitor methane emissions from landfills, and in the agriculture sector to assess methane emissions from livestock and agricultural processes. Their agility, rapid deployment capabilities, and affordability make them a practical choice in the field of methane emissions detection today.^[164]

Manned aircraft-based monitoring is expensive, and the high associated costs make it less suitable for regular monitoring

Table 14 shows the advantages and disadvantages of aerial surveillance technology

TABLE 14: Advantages and Disadvantages of Aerial Surveillance Technology

Advantages	Disadvantages
• Wide coverage area, making it ideal for monitoring remote or hard-to-access areas • Real-time immediate data collection in the case of drone technology • High sensitivity of sensors can detect methane emissions at relatively low concentrations • Cost-effective for large areas when compared with ground-based methods • Drones minimise risks associated with manual on-site inspections in hazardous environments	• Manned aircraft-based monitoring is expensive and requires skilled pilots, specialised equipment and substantial fuel consumption • Weather conditions can impact the monitoring process significantly

^[164] Pergam-Suisse AG, 'UAV Methane Detection - Latest Advances and the Current State of the Markets'

