

Introduction

Methane is the second most important greenhouse gas (GHG), in excess of 80 times more powerful than carbon dioxide (CO2) over a 20-year period. About 60 per cent of methane emissions come from human activities in the agriculture (40 per cent), energy (35 per cent) and waste sectors (20 per cent).

The reduction of global methane emissions is critical to keeping global heating within 1.5°C and preventing climate tipping points from irreversibly changing the planet's climate system.³ Without mitigation, methane emissions from all three sectors are projected to continue to increase steadily, by up to 150 per cent of 2010 emissions in 2100.⁴

According to the Global Methane Assessment (GMA), "global methane emissions must be reduced by between 40–45 per cent by 2030", 30 per cent of which can be achieved by readily available measures. Reducing methane by 45 per cent by 2030 would avoid 0.3°C warming by 2040, with significant co-benefits. For example, decreased

ground-level ozone formation would prevent hundreds of thousands of premature deaths and asthma-related hospital visits, as well as 226 million tonnes of crop losses each year.⁵ The overall monetised advantages, encompassing both market and non-market effects, amount to approximately \$4,300 for every tonne of reduced methane. The average cost per tonne of reducing methane emissions is lower, estimated at \$520 for oil and gas, \$190 for coal mines, \$2,900 for solid waste, \$830 for agriculture and \$3,240 for wastewater.⁶

In 2021, the European Union (EU) and the United States (US) launched the Global Methane Pledge (GMP), setting out a collective goal of reducing methane emissions by 30 per cent by 2030.

The GMP has catalysed interest in methane, spurring commitments and initiatives from governments, organisations and industries. However, a recent review estimated that only 13 per cent of methane emissions are currently covered by methane mitigation policies, while emissions continue to rise faster than ever.⁷

This briefing examines action taken to date under the GMP, identifies shortcomings in its implementation and highlights the need for strengthened global governance. This governance framework should be built alongside a new financial mechanism, the creation of ambitious individual targets and the systematisation of monitoring and mitigation measures across signatories to deliver on climate objectives for 2030 and beyond.

Below: Flaring results in emissions of CO2, black carbon, methane and other air pollutants, and can cause various health issues.





Implementation of the GMP

In the past two decades, the urgent need to reduce methane emissions has captured interest from policymakers and the public alike. The establishment of the Global Methane Initiative (GMI) in 2004 and the Climate and Clean Air Coalition (CCAC) in 2012 marked important milestones in enhancing methane recovery and mitigation.⁸

These initiatives, alongside others such as the Oil and Gas Methane Partnership (OGMP), the World Bank Zero Routine Flaring by 2030, the Global Methane Alliance and the Copernicus Sentinel Programme, have fostered increased awareness and accelerated actions to mitigate methane emissions.

At the 26th Conference of the Parties (CoP26) to the United Nations Framework Convention on Climate Change (UNFCCC), methane emissions received specific reference in the Glasgow Climate Pact, which urged Parties to "consider further actions to reduce by 2030 non-carbon dioxide GHG emissions, including methane". At the same time, the EU and the US co-announced the creation of the GMP, setting out a collective commitment to reduce global anthropogenic methane emissions across all sectors – energy, agriculture and waste – by 30 per cent from 2020 levels by 2030. In its first year, the GMP garnered support from more than 100 countries, representing nearly 50 per cent of global anthropogenic methane emissions and more than two-thirds of global gross domestic product (GDP). As of today, the initiative has been joined by 150 countries.

Since its creation, the primary focus of the GMP has been on catalysing action on methane monitoring and mitigation. Three pathways – one for each sector – were created to scale up projects and action plans, mobilise investments and accelerate research and innovation. One of the outcomes of the energy pathway was the creation of the Joint Declaration from Energy Importers and Exporters, a commitment led by the US, EU, Japan, Canada, Norway, Singapore and United Kingdom (UK) to work towards the reduction of GHG emissions associated with fossil fuel production and consumption.

To assist countries in monitoring their methane emissions, with a particular emphasis on emissions from the energy sector, the United Nations Environment Programme (UNEP) launched the International Methane Emissions Observatory (IMEO) in 2021. IMEO is a data-driven initiative intended to catalyse dramatic reduction of methane emissions by providing near real-time data on locations and quantity of methane emissions to countries and companies. One of the key projects of the IMEO is the Methane Alert and Response System (MARS), which links methane detection with notification processes. Additionally, the Global Methane Hub (GMH) was established as a philanthropic organisation offering financial assistance to countries to support the reduction of methane

Above: The launch of the Global Methane Pledge marks an important milestone as it is the first international initiative on methane mitigation.

emissions.¹⁶ This effort to finance methane abatement is particularly welcome, given that only two per cent of total climate finance flows are currently directed towards this urgent issue.¹⁷ Multiple organisations have also committed to contribute to technical assistance and project finance, such as the European Bank for Reconstruction and Development, the European Investment Bank and the Green Climate Fund.¹⁸

In April 2023, US President Joe Biden announced the "Methane finance sprint", supported by Canada, the EU, France, Germany, Ireland and Norway, which calls for countries to jointly raise at least \$200 million in new public and philanthropic support for developing countries before CoP28. 19

In its latest synthesis report on nationally determined contributions (NDCs), the UNFCCC Secretariat noted that 91 per cent of NDCs covered methane, ²⁰ compared to only 80 per cent in 2016. ²¹ It is expected this number will increase to 95 per cent in the next revision. ²² Some updated NDCs are accompanied by the development of methane action plans, published on the CCAC website, from the EU, Brazil, Canada, Finland, the Netherlands, Norway, UK, US and Vietnam. Additionally, Bangladesh, Cote d'Ivoire, Morocco and Nigeria have short-lived climate action plans with methane components, while Belgium, Cameroon, Colombia, Croatia, Estonia, Ghana, Liberia, Mali, Malta and Togo announced their intent to prepare national methane action plans by CoP28. ²³

As a result, a total of 44 countries out of 150 signatories have either developed or are in the process of developing methane action plans. Some countries have also implemented sector-specific measures, such as Mexico, which developed a methane regulation in the energy sector²⁴, while Malaysia's national oil company has set a target to reduce methane emissions by 50 per cent by 2025.²⁵

The CCAC has been playing a crucial role in assisting countries with the development of methane action plans. The coalition is actively working with 40 countries, particularly focused on supporting nations in the Global South. ²⁶ The projects include aspects such as the creation of methane roadmaps, support to deliver methane emissions inventories and help to incorporate short-lived climate pollutants in their NDCs.

The CCAC also organises regular workshops to provide training for GMP signatories on methane mitigation.²⁷ The work of the coalition goes beyond technical support and capacity-building, as it also provides financial assistance to countries for policy development. As of September 2023, the CCAC has been appointed to provide secretariat services to the GMP.²⁸



A significant overarching outcome of the GMP is its contribution to raising global awareness around methane. This impact is particularly evident within philanthropic organisations, notably with the alliance of more than 20 organisations which announced at CoP26 a commitment to fund more than \$328 million for methane mitigation.²⁹ The corporate sector has also responded. In March 2022, a group of 12 major oil companies, including Shell and Exxon Mobil, declared their commitment to reduce fugitive methane emissions, aiming to achieve near-zero levels by 2030.³⁰ A similar example exists in the agriculture sector, with Danone announcing plans to cut methane emissions from its dairy sector by 30 per cent by 2030.³¹

Overall, the GMP represents a crucial step towards methane mitigation. It has laid the groundwork for achieving its 30 per cent global methane emissions reduction target by providing support to signatories on monitoring and mitigation as well as technical and finance assistance.

The past two years were a chance for signatories to deliver on their commitments – and some have. However, despite this progress, the GMP's current trajectory suggests it will fail to meet its objectives. Methane levels in the atmosphere have continued to rise at unprecedented rates through 2022 and are now more than 2.5 times their pre-industrial levels.³² And despite its contribution to urgent near-term emissions reductions, finance for methane mitigation measures represents less than two per cent of total climate finance flows.³³ The following section explores how the GMP can be strengthened to deliver on its potential by 2030 and beyond.

Above: Despite the launch of the GMP, methane levels in the atmosphere have continued to rise at unprecedented rates through 2022 and are now more than 2.5 times their pre-industrial levels.

A strengthened global governance framework on methane

In order to deliver sustainable reductions in methane emissions, enhanced global governance is needed to provide an overarching framework to progress towards a collective commitment, while promoting international cooperation and coordination and enabling domestic action.

Central to this strengthened approach lies the need for countries to adopt a clear methane mitigation target. A target sets the baseline for any mitigation action plan, providing a clear objective to guide the measures adopted, as well as assess financial needs and establish a reference point to track progress. To deliver on the objective, financial and technical assistance as well as methane monitoring, reporting and verification (MRV) and concrete mitigation measures are needed.



Above: In the agricultural sector, livestock is by far the largest contributor of methane emissions, caused by the digestive systems of ruminants and manure management.

Financial and technical assistance

Following the collective experience of various multilateral environmental agreements, stable and predictable financial assistance for enabling activities is a critical component of any effective global governance framework.

For the purposes of delivering on the GMP, enabling activities can be grouped into the following types:

- **Institutional strengthening.** Institutional strengthening increases the ability of governments to perform essential functions and has become synonymous with support provided to ensure consistent and dedicated staffing within governments, for example "focal points"
- Capacity-building and training. Capacity-building and training are closely related to compliance, providing the skills, knowledge and tools to governments and key stakeholders to implement their obligations and commitments with greater effectiveness. Given the range of issues related to methane, capacity-building and training should feature prominently and be administered in an adaptive framework to remain responsive and relevant. In the report Post-Rio+20 review of environmental governance within the United Nations system (2014),

the Joint Inspection Unit identifies the lack of "dedicated resources for capacity-building" as a major shortcoming in all multilateral environmental agreements, with the exception of the Montreal Protocol, which is widely considered to be the most successful³⁴

- Monitoring, reporting and verification. An effective global governance framework on methane will require effective MRV. In previous international initiatives, such as Reducing Emissions from Deforestation and Forest Degradation (REDD+), countries overlooked the importance of building administrative competence and good governance, resulting in hindered progress. An effective MRV system will require early investment and support to institutionalise MRV into the industrial and bureaucratic landscape, making it regular and systematic while ensuring its utility as a performance and planning tool
- **Policy development and implementation.** The development and implementation of national policies to deliver methane emissions reduction in each sector is at the heart of the global governance framework and financial support should be provided to undertake these activities and update them over time.

Financial assistance for enabling activities should be provided to all signatories in need, on a grant basis, and should be supplemented by access to financing for investment costs related to implementation. For example, in the context of methane mitigation, this could include access to concessional financing for municipalities to invest in landfill gas recovery systems.

Between 2019-20, funding for methane abatement reached a total of \$11.6 billion. The private sector accounted for the biggest share of tracked financial flows and development financial institutions represented 13 per cent of all methane abatement flows in 2019-20. The Climate Policy Initiative estimated that more than \$110 billion a year is needed from private and public sources to reach the objective of the GMP.³⁶

The CCAC plays a pivotal role in channelling financial assistance to developing countries and supporting projects to monitor and mitigate methane from the three emitting sectors (see Fig 1). The CCAC is an essential point of contact for countries seeking assistance towards the enabling activities listed above. However, the current approach to funding remains fragmented, with three salient shortcomings that threaten to undermine its efficacy:

- **Financial assistance is inadequate.** Of the 150 signatories to the GMP, 108 are official development assistance (ODA) recipients, including low and middle-income countries and least-developed nations,³⁷ yet the CCAC currently supports only 40 of these signatories. Increased financial assistance for enabling activities would enable the CCAC to reach all developing countries in the GMP
- Financial assistance is project-based. Current funding is limited to specific aspects of methane monitoring or mitigation, lacking comprehensive support across all enabling activities and investment costs. The lack of comprehensive, sustained financial support means that many countries can focus only on specific aspects of methane emissions, resulting in gaps in their efforts. For example, a country may receive financial assistance to improve methane monitoring technology but lack the financial support to develop and implement effective policies to reduce emissions
- Financial assistance is unpredictable. The absence of a structured approach to providing financial assistance creates unpredictability, hindering countries from following through on commitments and setting clear timeframes for implementation. Countries often struggle to make necessary investments in human resources and infrastructure in the absence of consistent funding streams. This unpredictability hampers their ability to establish a well-structured, coordinated approach to methane monitoring and mitigation.

 $\textbf{\textit{Figure 1:}} \ \textit{Methane related activities funded by the CCAC. Source: CCAC. See Supplementary Materials for further details \\ \underline{\textit{here }} \ \textit{leave } \ \textit{l$

GMP signatories	150
20DA recipients that are signatories of the GMP	108
Number of countries supported by the CCAC on methane	40
Institutional strengthening	31 projects, 29 countries
Capacity-building and training	8 projects, 7 countries
MRV	16 projects, 11 countries
Policy development and implementation	36 projects, 29 countries
Pilot and demonstration projects	15 projects, 9 countries, 6 regions

To overcome these limitations, financial assistance needs to be delivered within a comprehensive framework by a dedicated fund designed for the purpose of implementing the GMP. This fund should have a clear mandate and be structured to maximise its effectiveness, serving as the central financial mechanism for enabling activities and coordinating access to finance for investment costs. Such a fund should have the following characteristics:

- **Donor contributions.** The primary source of funding should be donor countries. Recognising their historical responsibility for GHG emissions and their capacity to provide financial support, donor countries should take the lead in ensuring the fund's robust financial base
- **Long-term commitment.** Donor countries should commit to extend financial support via the fund until at least 2030, based on a needs assessment. This timeframe is crucial for developing countries to undertake multi-year planning and investments in methane monitoring and mitigation
- **Predictability.** Predictability is key to enabling countries to plan and execute comprehensive methane reduction strategies. This means setting out a transparent allocation procedure with clear criteria and guidelines for providing financial assistance, ensuring that funds are disbursed in a timely and reliable manner through 2030
- **Multilateral engagement.** Beyond donor countries, philanthropic organisations and multilateral development banks should be actively engaged to diversify funding sources, in particular as it relates to concessional finance for investment costs
- **Flexibility.** The fund should be adaptable, allowing countries to allocate resources based on their priorities and specific methane sources. Flexibility ensures that the financial assistance is tailored to the unique needs of each country
- **Accountability and transparency.** Accountability and transparency mechanisms should be put in place to ensure that funds are used efficiently and for their intended purposes and to track progress.

Financial assistance to developing countries should be supplemented by targeted technical assistance from implementing and bilateral agencies. Enlisting implementing and bilateral agencies to support developing countries with implementation leverages investment, enhances its effectiveness and increases the likelihood of taking on new commitments. In addition, by virtue of working across countries and regions, implementing and bilateral agencies are typically well-placed to share best practices and exchange knowledge.

The development of a fund dedicated to implement the GMP should be undertaken in parallel with the systematisation of methane monitoring and mitigation.

Below: Recent satellite, aerial and ground-based technologies are shedding light on the scale of methane emissions from oil and gas infrastructure.



Monitoring, Reporting and Verification (MRV)

MRV is the foundation of effective global governance. It enables one to assess both national implementation and overall progress and is a tool to build strategies and prioritise highest-emitting sources and sectors.³⁸

Central to this strengthened approach lies the need for countries to adopt a clear methane mitigation target. A target sets the baseline for any mitigation action plan, providing a clear objective to guide the measures adopted, as well as assess financial needs and establish a reference point to track progress.

To date, methane emissions from agriculture, energy and waste have largely escaped scrutiny from regulators and policymakers. The UNFCCC reporting guidelines on annual inventories require Parties to use the 2006 Intergovernmental Panel on Climate Change (IPCC) guidelines for national GHG inventories. In 2019, the IPCC published a Refinement to address gaps and incorporate advancements in scientific knowledge since 2006.³⁹ However, a 2021 investigation by the Washington Post revealed a significant disparity between the declared GHG emissions of countries and actual GHG emissions.⁴⁰ This inconsistency is due to different reporting formats as well as discrepancies in the scope and timelines of reporting. For methane in particular, the study found that human-caused methane emissions in 2019 were between 51-69 million tonnes (1.6-2.1 billion tonnes CO2-equivalent, CO2e), higher than indicated by country reports.

The International Energy Agency (IEA) further found that methane emissions from the energy sector were 70 per cent greater than the sum of estimates provided by national governments.⁴¹

In the agriculture sector, research by Changing Markets Foundation showed that none of the 15 largest meat and dairy companies reported their methane emissions.⁴²

To address this, methane mitigation MRV requires significant improvements:

- MRV should be harmonised. This includes developing common definitions, measurement methodologies and reporting formats and templates, with reporting required periodically to a designated entity, such as the CCAC. MRV should cover all three sectors and rely on the best available technologies as well as use existing initiatives. For example, in the energy sector, MRV should be aligned with the framework of the Oil and Gas Methane Partnership 2.0 (OGMP 2.0), a multi-stakeholder initiative launched by UNEP and the CCAC providing companies with a measurement-based reporting framework, setting out milestones and timeframes to achieve them. A strong MRV component will require companies to report their methane emissions, which should then be verified by an independent third-party. The IMEO has been playing an important role in supporting countries with MRV and could be formally included in any new MRV framework. Moreover, the data should be publicly available to scientists, policymakers and civil society, which would further support implementation. Currently, there is no central platform to track the progress of signatories to the GMP
- **Higher tier IPCC methodologies should be used.** For methane, this would be Tier 3 of the UNFCCC reporting guidelines, which requires more detailed data and or measurement than Tier 1 and Tier 2, which tend to rely on default emission factors and only the most basic and least disaggregated activity data. Moving to Tier 3 requires incorporating new aerial, satellite and ground-based technologies, dramatically increasing the quantity and accuracy of methane emissions data. While satellites have so far been mainly used to monitor methane emitted from the energy sector, a study from the World Bank shows that data from the European Space Agency's (ESA) Sentinel 5-P can also provide valuable information for monitoring methane emissions from irrigated rice production⁴⁴
- **Dedicated funding for MRV should be available.** Developing a well-functioning and accurate MRV requires early investment and support to institutionalise it into the industrial and bureaucratic landscape, making it a key enabling activity.

Mitigation

The GMP is currently based on a collective commitment to reduce methane emissions by 30 per cent by 2030. It is not, however, accompanied by an obligation for signatories to develop their own targets, nor any requirement to ensure they align with the collective one.

Given the variation in methane emissions contributions among countries and the considerable variability in mitigation potential across sectors, countries should be expected to make their fair contribution based on a common metric. For methane reductions beyond 2030, the GMA further found that the mitigation potential from all sectors is expected to increase, which could then form the basis for periodic review and update and help secure methane reductions over the longer term.⁴⁵

In this regard, countries should be required to adopt national methane action plans, setting out clear targets, country-specific policies and measures to transpose the GMP's collective commitment.

The fossil fuel sector has been identified as the sector with the most readily available mitigation potential and at low cost: up to 80 per cent of measures in the oil and gas sector and 98 per cent of measures in the coal sector could be implemented at negative or low cost. These measures include upstream and downstream leak detection and repair, pre-mining degasification and recovery of ventilation air methane in coal mines, as well as flooding of abandoned coal mines. The waste sector is the second sector with the most potential, with 60 per cent of measures at negative or low cost. The measure with the greatest result is the improved treatment and disposal of solid waste. Finally, in the agriculture sector, behaviour changes, food waste and loss reduction, improved livestock management and the adoption of healthy diets could reduce methane emissions by 65-80 million tonnes per year, with average costs varying across analyses.

Despite the cost-efficiency of methane mitigation measures, companies are still reluctant to implement them and regulations are clearly needed to incentivise the private sector to play a more constructive role. 50

Under the GMP, there is no obligation for signatories to develop national methane action plans or guidelines on how to approach reduction goals. Despite this, some countries have submitted national methane action plans to the CCAC. A review of national methane action plans from the EU, US, Canada and Vietnam demonstrates broad discrepancies in terms of chosen targets and policies.

- Targets. Vietnam includes a target to reduce methane emissions by 30 per cent by 2030 across the three sectors, whereas the EU, US and Canada do not.⁵¹ Canada does, however, include a 75 per cent methane emissions reduction target for its energy sector.⁵²
- **Policies.** Vietnam outlines all the policies it will need to develop across the three sectors, as well as regulations on methane inventories. However, the policies and regulations have no timeframes and for many remain vague, such as "formulate and revise mechanisms and policies for encouraging energy transition from fossil fuels to clean and renewable energy" and "formulate, revise and synchronously apply processes, regulations, guidelines and models for collection, transport, classification, reuse, recycling and treatment of solid waste." The EU, US and Canadian plans all heavily rely on existing regulations that have little relevance, with the exception of the energy sector where specific legislative texts have been identified. For example, the EU plan mentions its Land Use, Land Use Change and Forestry (LULUCF) Regulation, which "overall is expected to have a limited impact on absolute CH4 emissions in the EU," and the upcoming revision of the Effort Sharing Regulation, which does not have a methane reduction target. This contrasts with the ongoing development of the EU Methane Regulation to reduce methane emissions in the energy sector. Sector S

An additional overarching issue is that plans do not reflect best available practices, particularly for agriculture and waste measures. In the agricultural sector, countries rely heavily on technical solutions such as feed additives, although the GMA found that achieving a 45 per cent reduction by 2030 will require a combination of technical solutions and additional measures i.e., those that reduce methane without primarily targeting it, and achieving targets will require lifestyle changes.⁵⁶

For this reason, policymakers should also promote measures that lead to healthier human diets with less and better meat and dairy, along with more sustainable food production systems that will ultimately reduce the number of animals used for food. Countries in the Global North, where meat and dairy consumption is excessive, and where a large share of overall methane emissions come from animal agriculture, should prioritise this transition.

Even in a 2°C scenario, the required reduction in emissions linked to enteric fermentation is unlikely without a global change in human diets.⁵⁷ A study by Changing Markets Foundation found that from now to 2030, a mere 3.7 per cent reduction of non-CO2 emissions (including methane) in the agriculture sector in the EU is expected under current policies and developments, whereas the estimated total methane-reduction potential in EU livestock agriculture is 38-67 per cent by 2030, with the largest reductions from policies that encourage a switch to healthier diets.⁵⁸

Although the EU recognises that "additional action in other sectors than agriculture would not be able to ensure the 30 per cent ambition level of the Global Methane Pledge", it fails to present any new policies on the issue. Canada's plan projects only one per cent reduction in methane emissions in agriculture, despite these emissions constituting 30 of total methane emissions. This lack of ambition to address methane emissions in agriculture features almost across the board. Globally, just 36 per cent of NDCs include livestock-related mitigation interventions. Few countries approach the agricultural sector with measures promoting dietary shifts, despite their effectiveness.

In the waste sector, waste prevention is the most important methane reduction strategy as every tonne of organic material that never enters the waste stream avoids the methane it would have generated in landfill. Food waste, which is responsible for 10 per cent of all GHG emissions worldwide and most solid waste methane emissions, is especially important to avoid. Opportunities for waste prevention are available at every step of the supply chain, for example, amending subsidies that encourage food overproduction, instituting demand-planning programmes or food donation mandates in supermarkets, ensuring a sustainable cold chain and educating consumers about waste prevention. The US plan restates its 2015 target of reducing food waste by 50 per cent by 2030, but this has so far been unsuccessful as food in municipal solid waste sent to landfills continued to grow between 2015-19.

Overall, the comparison between the national action methane plans of the EU, US, Canada and Vietnam – and the absence of them in other countries – is reflective of the lack of a comprehensive and clear approach to mitigation. While national methane action plans need to be adapted to the context of each country, countries need clear guidance in terms of commitment and content. To this end, enhanced global governance on methane should include a requirement to develop national methane action plans, including targets, supported by clear guidelines on content, strategies and available technologies.

Below: The EU and the US jointly launched the Global Methane Pledge at CoP26 in Glasgow.



Conclusion

The GMP has catalysed increased awareness of methane emissions and the need to take urgent action, but an effective governance framework to ensure implementation is lacking.

The GMP, as it currently stands, remains just that – a pledge – without the necessary commitments, institutions, mechanisms and financial support to drive substantial change. To overcome these limitations and deliver methane emission reductions at scale, signatories of the GMP should design and implement a robust global governance framework around the GMP that incorporates clear national targets and mitigation measures, comprehensive MRV and a dedicated financial mechanism.

Recommendations

- Countries adopt targets, tailored to their context, based on common metrics, accompanied by mitigation measures across all three emitting sectors
- Donor countries take the lead in instituting a dedicated fund for methane monitoring and mitigation, with well-defined timelines extending through 2030, supported by philanthropies and multilateral development banks
- Access to the fund comes with obligations on developing methane action plans, supported by a robust governance and accountability mechanism
- MRV is harmonised between countries, with common definitions, measurement methodologies and reporting formats and templates, using the highest tiers, with periodic reporting to a designated entity
- Clear guidelines are developed for countries to develop methane action plans and policies, reflecting the best available practices.



Above: Methane emissions in the waste sector arise primarily from the anaerobic decomposition of organic waste in landfills.

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