From:	Carol McClelland Fields
To:	Coffin Butte Landfill Appeals
Subject:	Fwd: Oppose/Deny LU-24-027 – Coffin Butte Landfill Impacts on Health - Carol McClelland Fields
Date:	Sunday, October 19, 2025 6:06:02 PM
Attachments:	6 - Coffin Butte Landfill Impacts on Health - KunakAir.pdf 5 - AHA Journal - Cardiovascular and Cerebrovascular Emergency Department Visits.pdf

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Hello,

I've attached my testimony and supporting reference documents.

Please add them to the record for LU-24-027.

Two attached documents were too large to send in my first email.

Please note: Allow the large pdfs to fully populate before saving them. Otherwise the full documents are not saved and cannot be accessed.
Thank you.

Carol

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Carol McClelland Fields, PhD, BCC
541 243 3675
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Kern CA	0.8	47.3	39.0	9.7	3.2
Lake CA	0.9	47.7	38.7	9.7	3.0
Alameda CA	1.0	51.1	35.1	9.0	3.8
Los Angeles CA	1.0	51.7	34.7	8.9	3.7
San Mateo CA	1.0	52.1	34.4	8.8	3.7
Santa Clara, California CA	1.0	52.2	34.3	8.8	3.7

Table 1. Data are from 6 counties in California (Kern, Lake, Alameda, Los Angeles, San Mateo, and Santa Clara) and represent the proportion of patients with each race/ethnicity.

Figure 1. Data are from 6 counties in California (Kern, Lake, Alameda, Los Angeles, San Mateo, and Santa Clara) and represent the proportion of patients with each race/ethnicity. Darker shades represent higher percentages.

Continuous Variables

We defined 30-year-old-equivalent diagnosis and 50-year-old-equivalent diagnosis as the age at which a patient would be expected to have the same risk of cancer diagnosis as a 30-year-old and a 50-year-old, respectively, based on the age-specific incidence rates in the SEER 18 Registry. The prediction analysis of the age-adjusted the Kaplan-Meier estimate of the probability of cancer diagnosis at age 30 years was 0.0 (95% CI: 0.0, 0.0) for all patients, 0.0 (95% CI: 0.0, 0.0) for those with a family history of cancer, and 0.0 (95% CI: 0.0, 0.0) for those without a family history of cancer. The prediction analysis of the age-adjusted the Kaplan-Meier estimate of the probability of cancer diagnosis at age 50 years was 0.0 (95% CI: 0.0, 0.0) for all patients, 0.0 (95% CI: 0.0, 0.0) for those with a family history of cancer, and 0.0 (95% CI: 0.0, 0.0) for those without a family history of cancer. The age-adjusted Kaplan-Meier estimate of the probability of cancer diagnosis at age 30 years was 0.0 (95% CI: 0.0, 0.0) for patients with a family history of cancer and 0.0 (95% CI: 0.0, 0.0) for those without a family history of cancer. The age-adjusted Kaplan-Meier estimate of the probability of cancer diagnosis at age 50 years was 0.0 (95% CI: 0.0, 0.0) for patients with a family history of cancer and 0.0 (95% CI: 0.0, 0.0) for those without a family history of cancer (Table 2).

| | | | | |

Landfill air pollution: how it affects air quality

February 1, 2025 - Updated March 4, 2025

Written by the **Marketing & Communication Team**

Table of contents

What is landfill air pollution?

Sources of air pollution from landfills

Degradation processes in landfills and their impact on air

Pollutants released by landfills

Effects of landfill air pollution

Methane emissions from landfills

Air pollution control in landfills

How does Kunak help reduce atmospheric pollution in landfills?

Landfill Methane Outreach Program (LMOP)

Frequently Asked Questions

Conclusion

References

It is impossible to remain indifferent to the significant impact that our **waste** is having on both **human health** and the **planet**. There are solutions, but the growth of the **population** and **urbanisation**, along with **inadequate waste management** in **landfills** worldwide, make it difficult to tackle one of the greatest **environmental challenges**.

Current global **consumption** and **production models** exacerbate an already worldwide problem: the more **waste** we generate, the higher the **emissions** from **landfills**, laden with **toxic gases** and **substances** that **pollute the atmosphere**. In fact, **landfills** are responsible for **20% of the methane** released globally, a **greenhouse gas (GHG)** up to **80 times more potent** than **CO_2** in the short term.

Living near a **landfill** is living on the edge. The **local population** faces serious **health risks** due to **environmental pollution** and the damage caused to **ecosystems**. However, this is not just a **local problem**; **landfills** represent a **global threat**. Their **emissions** are the **third leading cause of global warming**, following **fossil fuels** and **agriculture**.

Solid waste management has been a challenge for decades, accumulating problems due to **inaction** or **inefficient management**. Although many developed countries have implemented more **sustainable strategies**, **urban growth** and **excessive consumption** continue to generate an **unsustainable accumulation of waste**.

This issue affects everyone globally, making it imperative to take **urgent action** to mitigate it.

> *The world generates 2.01 billion tonnes of municipal solid waste annually, of which at least 33%—a very conservative estimate—is not*

> *managed safely for the environment. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*, World Bank Group.

This article examines the environmental damage and the direct impact on public health caused by landfill emissions, as well as potential solutions to curb their effects.

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What is landfill air pollution?

Landfill air pollution occurs due to the **release of harmful gases and particulate matter** generated during the decomposition of solid waste. This process, involving **physical, chemical, and biological reactions**, results in **methane**, **carbon dioxide**, **and airborne particulates** that negatively affect **air quality** and intensify the **greenhouse effect**, the primary driver of **climate change**.

One of the **main contributors** is the **anaerobic process** (in the absence of oxygen) that occurs when organic waste decomposes in **landfills**.

This process is a **significant source** of methane gas, the second most harmful greenhouse gas derived from human activities, only surpassed by **CO_2**. What we consume daily becomes a **global problem** when waste ends up in landfills. **Inadequate waste management** directly affects our health by polluting water, degrading the soil that feeds our crops, and deteriorating the air we breathe.

Municipal solid waste landfill site and sealed areas of the facility.

Sources of air pollution from landfills

Landfills are a significant source of air pollution due to the **release of gases and particles** from waste decomposition and associated operations. These are the **main sources** of air pollution in landfills:

Waste and direct management

These sources are directly related to the materials deposited in the landfill and their decomposition:

- Decomposing organic waste.
- Hazardous and chemical waste (such as solvents, batteries, paints).
- Secondary biological processes (microbial activity generating gases such as ammonia and hydrogen sulphide).

Landfill infrastructure and operation

These sources are linked to the design, management, and maintenance of the landfill:

- Poorly sealed waste cells.
- Leaks in biogas capture systems.
- Improper leachate management.
- Inadequate or insufficient temporary covers.

Operational activities

Emissions generated by the necessary operations to manage the landfill:

- Waste movement and compaction (use of heavy machinery).
- Vehicles transporting waste to the landfill.

Combustion processes

Sources related to the burning of waste or fuels:

- Waste burning (intentional or accidental).
- Combustion of fossil fuels in machinery and vehicles (emissions of CO_2, NOx, and PM).

Release of particles and volatile compounds

Emissions from materials that volatilise or become suspended in the air:

- Leachates that volatilise and release pollutants.
- Release of dust and suspended particles (PM10 and PM2.5) due to machinery movement or unpaved roads.

Degradation processes in landfills and their impact on air

Biological

In landfills, microorganisms break down organic waste in two stages:

- **Aerobic:** Occurs in the presence of air and generates few atmospheric pollutants, but does produce odours and particles.
- **Anaerobic:** Microorganisms break down material in the absence of oxygen, releasing methane (CH_4) and carbon dioxide (CO_2), two greenhouse gases that contribute to global warming. This process also generates suspended particles such as volatile organic compounds (VOCs).

Additionally, if the waste contains sulphur (present in certain foods and plastics), specialised bacteria produce **hydrogen sulphide (H_2S)**, a toxic gas with an unpleasant smell.

Chemical

Chemical reactions in landfills occur due to the interaction of waste with water, air, and microorganisms:

- **Release of CO_2:** Carbon-containing waste, such as wood or paper, reacts with oxygen releasing carbon dioxide and thermal energy.
- **Formation of CH_4:** Waste rich in carbonates (from domestic, industrial, or food waste) produces methane through chemical reactions.
- **Hydrolysis and fermentation:** Fats, proteins, and carbohydrates release ammonia (NH_3) and alcohols, which become atmospheric pollutants.

Physical

Physical processes in landfills also contribute to air pollution:

- **Transport and compaction movements:** Release trapped gases such as CO_2 and CH_4, and generate suspended particles.
- **Heat from decomposition:** Biological and chemical reactions generate heat, driving the volatilisation of toxic compounds and even spontaneous fires.
- **Waste burning:** Especially plastics or materials with chlorine, which produce dioxins and furans, extremely toxic compounds for health.
- **Leachates:** Liquids circulating through the waste carry heavy metals and chemicals that may evaporate and contaminate the air.

- **Wind-blown particles:** Handling dry waste and its degradation generates dust and suspended particles that end up in the atmosphere.

Pollutants released by landfills

Landfills generate a variety of **pollutant gases** and **suspended particles** that are slowly released into the atmosphere. If they lack **biogas capture systems**, these pollutants enter the air. **Biogas**, generated by the **anaerobic degradation** of organic waste, is a mixture of **methane (CH_4)** and **carbon dioxide (CO_2)**. The following are the main pollutants:

Methane (CH_4)

Methane is a **greenhouse gas** highly harmful for its ability to **trap heat** in the atmosphere. It is the **second most potent gas** in intensifying the **greenhouse effect**, after CO_2, and contributes significantly to **global warming**.

Carbon dioxide (CO_2)

Also known as **atmospheric carbon**, CO_2 is a critical indicator of the **planet's health**. While essential for biological processes, **human activities have disrupted its balance**, raising its levels, intensifying the **greenhouse effect**, and accelerating **climate change**.

Volatile organic compounds (VOCs)

These **hydrocarbons** are **chemical substances** containing carbon and are in gaseous form at ambient temperature. Their **high volatility** makes them dangerous **air pollutants**, as well as precursors of tropospheric ozone.

Suspended particles (PM)

PM comes from both natural sources, such as dust and pollen, and human activities, such as **burning fossil fuels**, **industry**, and **agricultural processes**. These microscopic particles remain in the air and are associated with **respiratory and cardiovascular diseases**.

Together, these **toxic gases** and particles pose a serious risk to **human health**, increasing the incidence of **respiratory**, **cardiovascular**, and **neurological diseases**. They also contribute to **climate change** and **ecosystem degradation**.

Effects of landfill air pollution

Landfill air pollution results from a complex mix of **gases and particles generated by waste decomposition**. This issue worsens when the waste includes hazardous materials, increasing the overall emission profile and complicating its management.

One of the major environmental challenges today is managing this pollution effectively. To address this, it is essential to implement innovative strategies, such as installing **advanced gas detection and control systems**, capable of:

- Detecting emissions in real-time.

- Capturing and treating gases such as methane before they reach the atmosphere.

These preventive systems can significantly reduce the amount of harmful gases released, contributing to protecting air quality.

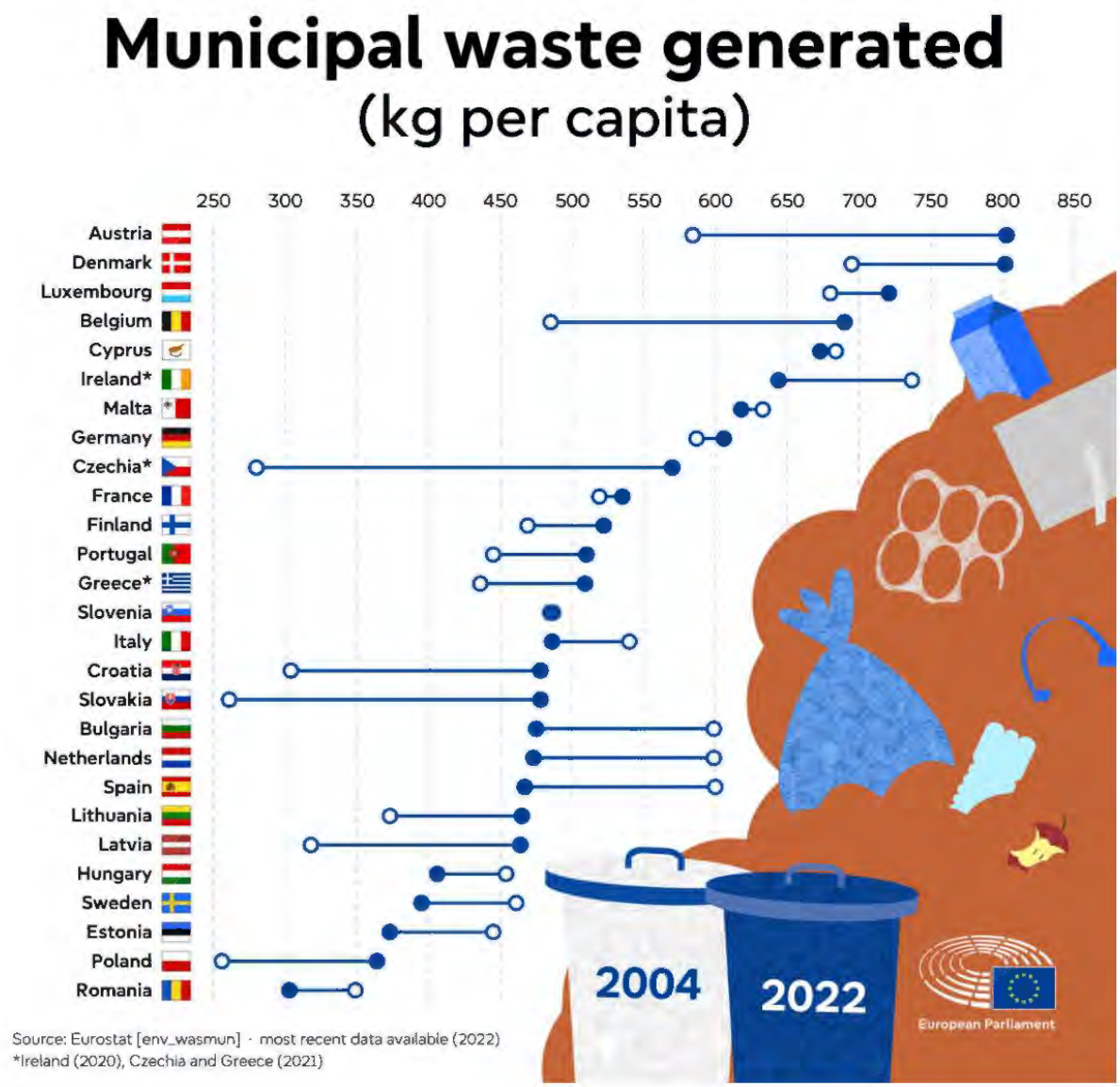
The implementation of **stricter regulations** and advanced control programmes encourages landfill operators to adopt better practices. This balanced approach allows minimisation of atmospheric emissions, ensuring effective waste management without compromising public health or air quality.

> *If no urgent action is taken, by 2050 global waste levels will exceed current levels by 70%. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. World Bank Group*

Reducing landfill dependence requires investing in sustainable and innovative approaches, such as:

- **Energy recovery technologies:** Extracting energy from gases generated in waste not only reduces emissions but also turns a problem into a **valuable resource**.
- **Source separation and recycling:** Improving **waste sorting** increases reuse and recycling, reducing the amount of materials that reach landfills.

In summary, adopting **sustainable measures** for landfill management will not only reduce their impact on **air pollution**, but also improve **air quality** and protect public health. These actions are crucial for ensuring a **safer and healthier environment** for future generations.



Municipal Waste Generated – European Parliament.

How landfill emissions affect public health

The release of harmful gases and particles from landfills poses a **direct threat to human health**, especially for those living near these waste processing sites.

Research has shown that exposure to landfill air emissions can cause a range of **adverse effects on public health**, including chronic respiratory problems

such as asthma and chronic obstructive pulmonary disease (COPD); as well as neurological issues and even cancer.

Municipal waste landfills typically house a harmful mix of waste, combining domestic, commercial, and industrial materials. This complex mixture can release a cocktail of atmospheric pollutants that are **difficult to monitor and control**.

The **social and economic repercussions** of landfill air pollution are significant, as they increase healthcare costs and reduce the quality of life for affected communities.

Municipal solid waste landfill.

What are the effects of landfills on local air quality?

Landfill air emissions, primarily composed of **methane**, **carbon dioxide**, and **volatile organic compounds (VOCs)**, pose a significant threat to the environment and the health of people living near these facilities.

The population residing near landfills is exposed to higher pollutant levels, which can worsen conditions such as:

- **Asthma**, **bronchitis**, and other respiratory diseases.
- More severe chronic conditions, such as **cancer** and **cardiovascular disorders**, in case of prolonged exposure.

The impact is even more severe on vulnerable groups, such as **children**, **elderly people**, and those with pre-existing conditions, as their health is more sensitive to **air quality** affected by these emissions.

The constant increase in waste volumes has led to the location of landfills closer to **urban areas**, where their emissions exacerbate atmospheric pollution in densely populated regions. Additionally, the expansion of these facilities to manage the **growing volume of waste** intensifies the need to control and mitigate pollutant emissions.

To protect public health and ensure **clean air**, it is crucial to adopt effective strategies:

1. **Control of pollutant gases:**
   - **Early detection and gas capture systems**.
   - **Controlled flaring** to reduce methane emissions.
   - Use of **biofilters** to filter harmful gases.

2. **Sustainable waste management:**
   - **Promotion of recycling** and waste reduction at source.

- Implementation of **alternative treatment methods** to reduce landfill dependency.

A comprehensive approach that combines **constant monitoring of pollutant gases** with compliance to current regulations is essential to address the effects of landfill emissions on air quality. Furthermore, the commitment of the **community**, promoting sustainable waste management practices, will be key to protecting both **public health** and the **environment**.

What regional and global impact do landfills have?

Municipal solid waste landfills have significant impacts at both **regional** and **global** levels, affecting the **environment**, **human health**, and the local economy.

Regional impacts: health, economy, and air quality

Landfill air pollution, especially through emissions of **pollutant gases** and **volatile organic compounds**, has direct consequences:

- **Public health:** Pollutants affect the **local population**, increasing respiratory diseases and other chronic conditions.
- **Local economy:** Areas near landfills experience a **decline in property value** and increased **healthcare costs** due to environmental impacts.
- **Air quality:** Emissions accumulate and deteriorate the air at a **regional** level, worsening atmospheric pollution.

Global impacts: climate change and sustainability

Landfills are one of the largest sources of **methane** and **carbon dioxide**, two powerful greenhouse gases contributing to **global warming**. Additionally, the slow decomposition process of waste (which can extend for centuries) **prolongs the environmental impact** even after landfill closure.

What is the environmental impact of landfills?

Local ecosystems suffer multiple consequences:

- **Habitat destruction:** Landfill expansion leads to the loss of **biodiversity** by disrupting local flora and fauna.
- **Soil and water contamination: Leachate**, liquids from decomposing waste, can seep into the ground, polluting **groundwater** and endangering both ecosystems and human health.
- **Depositing pollutants:** These can accumulate in vegetation, soil, and water bodies, affecting the entire environmental balance.

Strategies to mitigate the impact of landfills

1. **Reducing atmospheric emissions:** Implement **gas detection, capture, and utilisation systems** like methane.
2. **Sustainable waste management:** Improve **recycling** and **composting** programmes to divert organic waste from landfills.
3. **Renewable energy sources:** Harness captured gases as energy, achieving a **dual environmental and social benefit**.

International cooperation: key to change

Fighting the impact of landfills requires coordinated action:

- Global initiatives such as the Paris Agreement promote landfill emission reductions as a key part of **global climate goals**.
- Collaboration between countries is essential to mitigate the effects of an environmental crisis that **knows no borders**.

The combination of **advanced technology**, **improved waste management**, and **effective international cooperation** can transform landfills into sustainability models. Reducing their emissions will not only help curb climate change but also improve **quality of life** and the **health of the planet** for future generations.

Methane emissions from landfills

Decomposition of solid waste in landfills generates **pollutant gases**, primarily **methane** and **carbon dioxide**, both considered **greenhouse gases** (GHGs) that contribute to **climate change**. **Methane**, in particular, is especially concerning due to its **potent ability** to trap heat in the atmosphere. Although it remains for only **10 to 12 years**, its **global warming potential** is **25 times higher** than carbon dioxide over a 100-year period, making it one of the primary causes of **global warming**.

Sources of methane in landfills

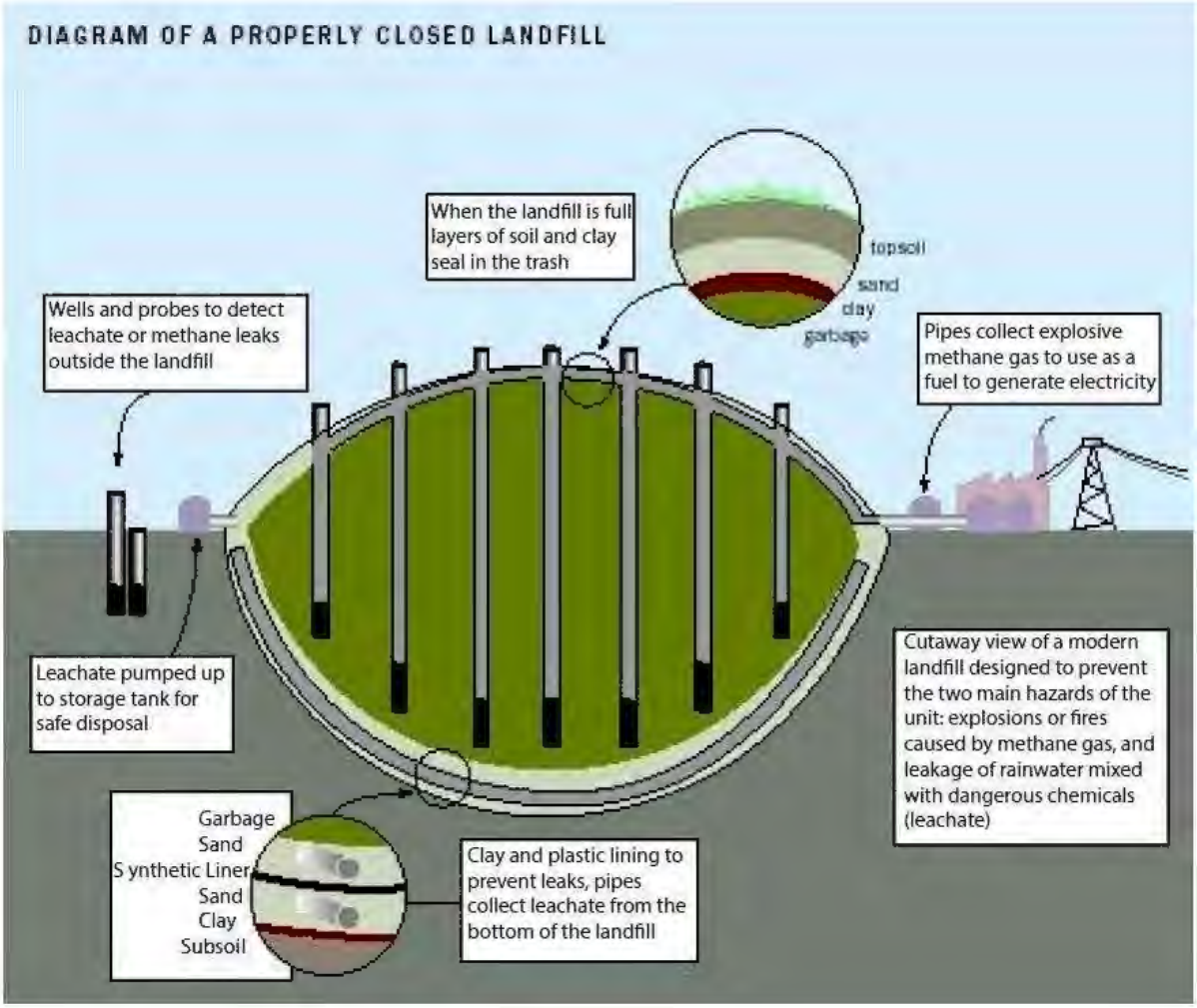
Landfills are a key source of **methane** due to the **anaerobic decomposition** of **organic waste**. The large amount of **garbage** that accumulates in these sites, along with the growing urban populations and increased consumption, makes waste management and associated emissions increasingly difficult. The expansion of landfills and the growing volume of waste complicate the **effective management** of atmospheric emissions.

Challenges in reducing methane emissions

Reducing methane emissions in landfills faces **technical**, **regulatory**, and **economic** challenges. The diversity of deposited waste, ranging from **municipal waste** to **hazardous waste**, contributes in various ways to methane emissions. This **complexity** makes it difficult to implement **universal solutions** that can be effectively applied in all landfills.

Moreover, the infrastructure required to **capture and utilise methane** is often costly and demands high technical standards. Many older landfills lack **methane capture systems**, and upgrading these facilities may be economically unfeasible. **Regulations** governing emissions vary significantly between regions, resulting in **inconsistent applications and compliance** globally.

> *According to the EPA, US landfills release methane equivalent to the carbon emissions of 23.1 million gasoline-powered cars driven for one year. Conservation Law Foundation*



Landfill sealing diagram – credit US EPA

Methane regulation in landfills: key measures

Methane regulation in landfills focuses on controlling and reducing emissions of this potent **greenhouse gas**. These regulations usually include the following aspects:

- **Mandatory biogas collection**: Many countries require landfills to install **biogas capture systems**, using wells or pipes, to collect methane generated by the anaerobic decomposition of organic waste.
- **Use of captured biogas**: The **captured methane** can be controlled by flaring, converting methane into carbon dioxide. It can also be used to generate **energy**, such as electricity or thermal energy, or, once purified,

used as **natural gas**. This reduces emissions and promotes **sustainable practices** in waste management.

- **Landfill planning standards**: Many regulations require **impermeable covers** to minimize methane generation and its release into the environment. **Geomembranes** and **compacted clay** are used to reduce emissions of pollutant gases and **odours**. In closed landfills, these covers are essential to seal the waste and prevent water infiltration, thereby avoiding the **production of leachate**.
- **Drainage systems**: These are employed to control leachate, preventing water accumulation that could increase **methane** and other GHGs. Leachate is treated through **reverse osmosis** and other physicochemical methods. In addition, toxic vapours generated by these leachates can be detected through **strategic monitoring** and treated before reaching the atmosphere.
- **Methane emission limits**: Some regulations require **continuous monitoring** of methane emissions, with regular reports on the data collected. In case of non-compliance, penalties are imposed.

Municipal solid waste collection.

Incentives and funding for reducing methane emissions

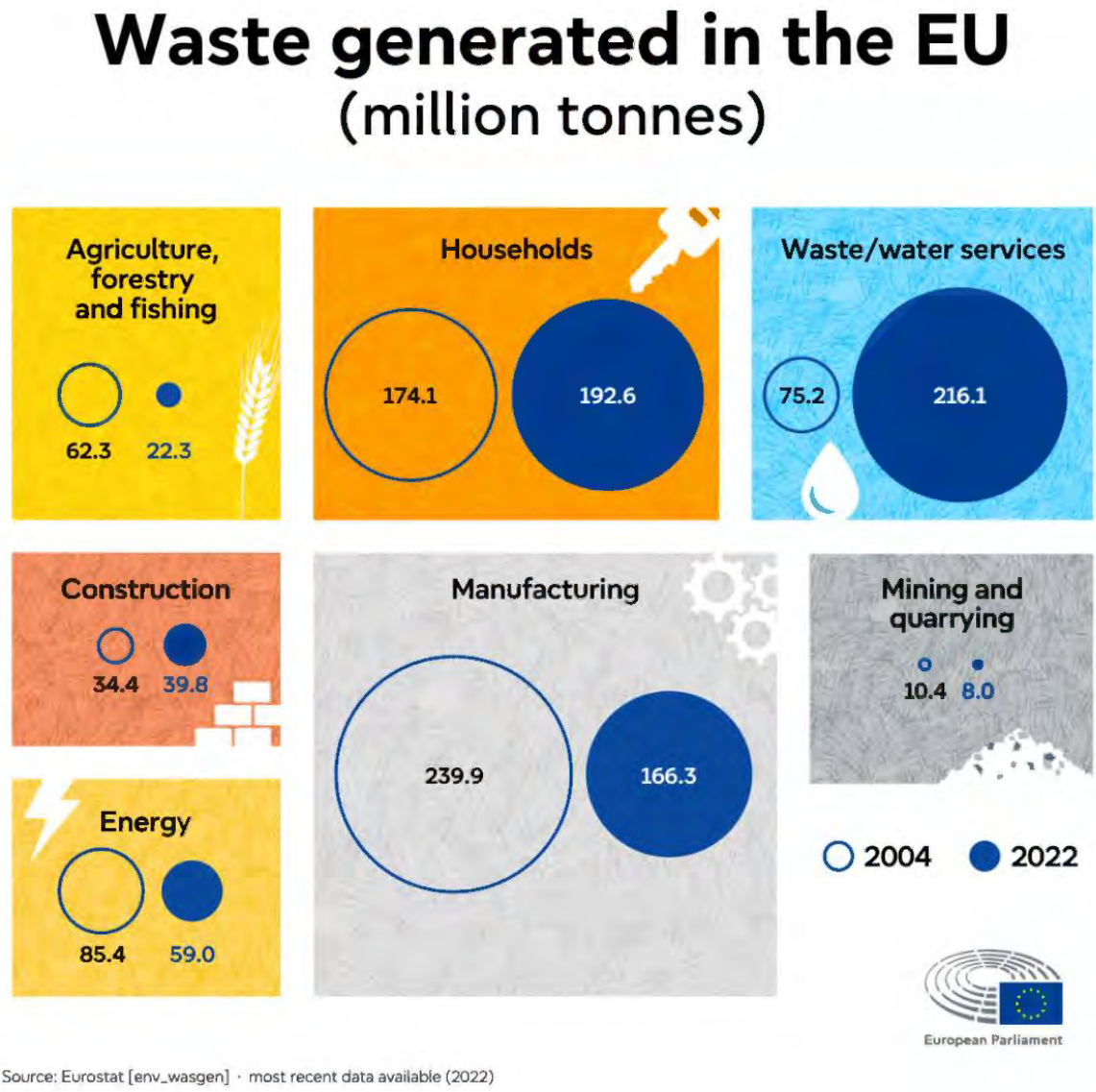
To encourage methane capture, there are various **incentives** and **funding options** available:

- **Clean Development Mechanism (CDM)**: Established under the **Kyoto Protocol**, this mechanism offers **international funding** and carbon credits to projects that capture methane directly from landfills, helping mitigate climate change.
- **Grants and tax incentives**: Some countries offer **grants** and **tax exemptions** for projects promoting **methane emission reduction** in municipal solid waste landfills.
- **Waste disposal restrictions**: The **European Union** and other regions have established regulations limiting biodegradable waste in landfills,

thus reducing the amount of **potentially generated methane**.

The **efficient management** of methane emissions from landfills is key to mitigating **climate change**. With a combination of **advanced technology**, **effective regulations**, and **international cooperation**, we can significantly reduce emissions and promote a more **sustainable** and **healthy** future.

> *By 2030, 60% of daily waste collected and treated by municipalities must be reused or recycled, according to EU goals. European Parliament*



Waste generated in the EU – European Parliament.

Air pollution control in landfills

Air pollution control in landfills is crucial for reducing environmental impacts and protecting **public health.** The most commonly used measures and technologies to control these emissions focus on **reducing biodegradable waste** entering the facilities, which reduces the emission of **biogas**.

Among the most advanced and accessible technologies for managing emissions and mitigating risks in landfills is **continuous air monitoring**. **Air quality sensors**, strategically installed in the landfill, form networks that provide **real-time data** and detect emissions of **pollutant gases**, **volatile organic compounds**, and **particulate matter**.

Using these technologies ensures compliance with **air quality regulations** that govern the emissions of pollutant gases such as **methane**, **carbon dioxide**, and other pollutants from landfills.

In summary, **air pollution control** in landfills not only helps reduce **GHGs**, but also improves **local and regional air quality**, minimizes **odours** and **health risks**, protects **ecosystems** and **biodiversity**, and makes it possible to harness **biogas** as a valuable source of **renewable energy**.

Gas control technologies in landfills

To mitigate the risks of landfill emissions, **advanced gas monitoring technologies** have been developed. These provide **real-time data** on the **composition**, **concentration**, and **emission rates** of gases, facilitating the management of emissions.

One of the most effective technologies is **gas chromatography**, which allows precise analysis of gas samples. This method helps identify specific components of each gas and apply management strategies to reduce emissions. Additionally, **infrared gas analyzers** are widely used for **continuous monitoring**, providing crucial data for the **early detection** of any anomalies or peaks in emissions.

The incorporation of **remote sensing** technologies and **Geographic Information Systems (GIS)** has transformed emissions control in landfills,

offering a global view of emission patterns. The use of **satellite images** and **aerial analysis** helps track gas emissions over time and allows for more informed strategic decisions.

The Internet of Things (IoT) has led to the development of **smart monitoring systems**, where sensors distributed across landfills transmit data to centralized platforms for analysis. This improves the **accuracy** of monitoring and enables the creation of **predictive models** for future emission trends.

In summary, gas control technologies in landfills continue to evolve, playing a fundamental role in **reducing air pollution**, ensuring **regulatory compliance**, and protecting both public health and the environment.

Odor emission control in landfills

Odor emissions in municipal solid waste landfills are a major concern for environmental health and the wellbeing of nearby communities. These odours come from the decomposition of organic matter, releasing harmful gases such as **hydrogen sulphide** and **methane**, which affect air quality.

Effectively controlling odour emissions through **constant monitoring** is essential to mitigate these impacts. This transforms landfills into more **sustainable** and **community-friendly** facilities, while also ensuring **compliance with environmental regulations**.

One of the most common methods for controlling odours is the use of **daily cover materials**, such as soil or synthetic alternatives, applied to waste to minimise the release of **malodorous gases**.

Additionally, some landfills have implemented advanced techniques, such as **biofiltration systems**, which use **microorganisms** to break down **volatile**

organic compounds and other odour-causing substances. This technology significantly reduces odour emissions before they reach the atmosphere.

A Kunak AIR Pro air quality station installed at a landfill site in Portugal to monitor methane emissions and other pollutant gases.

How does Kunak help reduce atmospheric pollution in landfills?

Kunak Technologies plays a key role in combating the **pollution** generated by municipal solid waste landfills through advanced technological solutions for **air quality monitoring**. Below are the main **contributions** of Kunak:

Monitoring of pollutant gases

Kunak provides **real-time air quality monitoring systems** that allow measurement of **pollutant gases** such as **methane**, **hydrogen sulphide**, **carbon dioxide**, and **ammonia** near landfills. This monitoring is crucial to **assess** and **control emissions** that impact both the **environment** and **public health**.

Establishing perimeter sensor networks

The use of **air quality sensor networks** around landfills allows accurate data collection on the **presence of pollutants** in surrounding areas. These networks help **identify emission sources** and implement **corrective measures** that protect the **health** of **local communities**.

Solutions tailored to specific projects

Thanks to **Kunak AIR** systems, based on the patented design of **smart cartridges**, monitoring solutions can be precisely tailored to the needs of each project. This includes compliance with **current regulations** and consideration of **environmental conditions** at the installation site and the **specific pollutants** to measure.

Success story: Ada County landfill, Idaho

The largest landfill in Idaho, located in **Ada County**, in collaboration with Envirosuite, has implemented an advanced **real-time environmental monitoring strategy** to manage **emissions** more efficiently and address the challenges of urban growth. Using innovative systems, such as the state-of-the-art Kunak AIR Pro sensors and digital platforms, constant **air quality**

monitoring is carried out, and **mitigation strategies** are established to protect both the environment and neighbouring communities.

In addition to ensuring **regulatory compliance**, this initiative has improved **stakeholder relations**, fostering **environmental resilience** and long-term sustainable management. This model not only ensures cleaner and more efficient operations but also aligns with the challenges of **urban expansion** and sustainable growth in the county.

Success story: Cerro Patacón landfill, Panama

A notable example of Kunak's application is the project developed at the Cerro Patacón landfill in Panama. Located near Panama City, this landfill implemented a **real-time control system** for **odour emissions** and **suspended particulate matter**. This initiative has significantly improved **air quality** and protected the health of **nearby communities**.

Success story: Valdemingómez landfill, Spain

Another example is the Valdemingómez landfill, a large waste treatment facility located in the southeast of Madrid, Spain. Since landfills are one of the primary sources of methane emissions, among other gases, a **Kunak AIR Pro sensor network** has been deployed to measure hydrogen sulphide (H2S), methane (CH4), volatile organic compounds (VOCs), and ammonia (NH3) emissions, and **alert for potential leaks**, optimising the **environmental control** of the complex.

In summary, Kunak provides advanced technological solutions for **monitoring and controlling atmospheric pollution** in landfills, thus helping

to mitigate their impact on both the **environment** and **public health**.

Landfill Methane Outreach Program (LMOP)

The **Landfill Methane Outreach Program (LMOP)** is a voluntary initiative by the **United States Environmental Protection Agency (US EPA)** aimed at **reducing methane emissions** from landfills by implementing **biogas recovery systems**.

After identifying landfills with potential for biogas capture, the program provides **tools**, **resources**, and **training** to stakeholders to design and develop **biogas recovery projects**. Through **awards** and **honourable mentions**, LMOP recognises organisations leading the most successful projects in **waste treatment** and methane emission reduction.

Program objectives

The main goal of LMOP is to **reduce methane emissions** from **municipal solid waste landfills** in the United States by encouraging the **capture and utilisation of biogas** produced during waste decomposition. The key objectives are:

1. **Reduce methane emissions**: Promote biogas capture technologies to decrease methane emissions from landfills.
2. **Encourage biogas utilisation**: Promote the use of biogas to generate **electricity**, produce **heat**, incorporate **renewable natural gas**, or use it as **fuel for vehicles**.
3. **Foster public-private collaboration**: Act as a facilitator for sustainable interaction between landfill owners, businesses, local governments, and project developers.
4. **Mitigate climate change**: Capture and use methane to reduce **greenhouse gas (GHG) emissions**, contributing to **national and international climate goals**.

LMOP benefits and achievements

The benefits of this program are multiple, both **economic**, **social**, and **environmental**:

- **Economic**: Generating income through the sale of **renewable energy** or **carbon credits**, as well as **reducing landfill operational costs** by promoting biogas utilisation.
- **Social**: Improving **public health** by reducing **odours** and **harmful gases** around landfills, benefiting **local communities**.
- **Environmental**: Contributing to **climate change mitigation** through **methane emission reduction**, improving local **air quality**, and promoting sustainability.

Methane emissions from a Madrid landfill detected on 20 August 2021 – European Space Agency.

Frequently Asked Questions

What causes air pollution at landfills?

Urban solid waste **landfills** generate **air pollution** through chemical and biological processes, releasing **greenhouse gases** such as **methane** and **carbon dioxide**, along with **volatile organic compounds** (VOCs) that affect air quality. They also emit harmful **gases** such as **hydrogen sulphide** and **ammonia**, which cause unpleasant odours, as well as **particulate matter**. Spontaneous fires release **carbon monoxide**, **dioxins**, and **furans**, substances harmful to health.

Can living near a landfill make you Ill?

Yes, living near a landfill increases the risk of health problems, such as **respiratory issues** from inhaling particles, gases, and VOCs. Prolonged exposure to substances like **benzene** and **toluene** can cause **neurotoxic effects**. Additionally, **PM2.5 particles** affect the **cardiovascular system** and increase the risk of **hypertension** and **heart disease**. There is also the risk of exposure to **carcinogenic substances** like **dioxins** and **heavy metals**. Although **bad odours** are not directly dangerous, they affect psychological well-being.

How far from a landfill is it safe to live?

People living within 5 km of a landfill without proper gas and leachate control are more exposed to emissions. Health risks depend on factors like **distance**, **waste type**, and **environmental control practices**.

What pollutants are commonly released by landfills?

Landfills release **greenhouse gases** (**methane** and **carbon dioxide**), **odorous gases** like **hydrogen sulphide** and **ammonia**, **volatile organic compounds**, and **particulate matter** (PM10, PM2.5). Leachates carry heavy metals like **lead** and **mercury**, and uncontrolled burning produces **dioxins** and **furans**, which cause **cancer**.

Overall, the pollutants released in landfills have **serious impacts on air quality, climate, and public health**. Therefore, it is crucial to **implement control measures**, such as gas capture systems, **continuous monitoring** with advanced technologies (like Kunak solutions), and **promote sustainable practices** in waste management.

How are landfill gases controlled and managed?

Biogas management is key to mitigating environmental impact. **Gases** like **methane** and **carbon dioxide** are captured through **wells** and **extraction pipes**. Impermeable covers are also used to prevent gas leaks. Biogas can be **burned** to generate **electricity** or produce **biomethane** for **fuel**. Additionally, emissions control includes **controlled flaring** of biogas. To optimise these processes, continuous **gas** and **particulate** monitoring using technologies like Kunak's sensors is essential, enabling real-time evaluation and control of emissions.

Kunak's CH_4, CO_2, H_2S, and VOC gas sensors enhance the continuous monitoring of control networks and assist in **making informed decisions** to **protect public health** and comply with **environmental regulations**.

Conclusion

The management of urban solid waste landfills represents **a major environmental challenge** due to the pollutant emissions from their processes. As emissions that **contribute to climate change** due to their high generation of GHGs, they also **affect air quality** and **public health** in nearby communities. These are reasons why it is **essential to measure and control** emissions and make informed and effective decisions based on the **timely detection** and **precision** of specific pollutants such as harmful gases, VOCs, and particulate matter.

This is the path to ensuring **more sustainable management** at treatment facilities and favouring their **compliance with current regulations** to mitigate their negative environmental and **public health** impacts. This practice should be generalised to **respond to the urgent need to drive a**

transition towards more responsible practices, aligned with global sustainability goals and environmental protection.

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Table of contents

What is landfill air pollution?
Sources of air pollution from landfills
Degradation processes in landfills and their impact on air
Pollutants released by landfills
Effects of landfill air pollution
Methane emissions from landfills
Air pollution control in landfills
How does Kunak help reduce atmospheric pollution in landfills?
Landfill Methane Outreach Program (LMOP)
Frequently Asked Questions
Conclusion
References

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