# Mitigation potential of super-emitting landfills in Brazil

Estimating methane mitigation potential and abatement costs using satellite observations and landfill gas system cost modelling

## 1 Executive summary

This study assessed methane emissions and mitigation opportunities at 66 landfill sites in Brazil identified as methane super-emitters through Carbon Mapper satellite methane observations retrieved from September 19, 2024, to July 7, 2026. Based on annualised Carbon Mapper observations processed using Monte Carlo uncertainty propagation, the assessed sites emit an estimated 642 kilotons of methane per year ($ktCH_4$/year), equivalent to approximately 29% of methane emissions from Brazil's solid waste disposal sector reported by Brazil Greenhouse Gas Emissions and Removals Estimating System (SEEG).

The analysis estimates that approximately 456 $ktCH_4$/year of the observed emissions (71%) could be mitigated through improved landfill gas collection and utilisation. Most of this potential (266 $ktCH_4$/year) is associated with sites that have existing gas collection systems in place, indicating that optimisation and expansion of existing infrastructure may be as important as installing new gas collection systems.

The results show that a small number of sites account for a higher share of the total mitigation potential. The top 10 emitting sites account for 37% of the total mitigation potential from the 66 super-emitters, while the top 20 emitting sites account for 57%. The 20 highest emitting sites also have the lowest abatement costs, making them attractive candidates for near-term action.

Across all the landfill sites, mitigating methane emissions through interventions at the landfill appears possible at a relatively low cost. Of the 66 assessed sites, 57 have abatement costs below 10 USD per ton of carbon dioxide equivalent (USD/$tCO_2e$). The weighted average abatement cost is approximately 5 USD/$tCO_2e$ for the top 10 sites, increasing to 7 USD/$tCO_2e$ for the top 20 sites. For all assessed landfills, carbon markets, climate finance and revenues from landfill gas utilisation could help improve project economics and unlock additional emission reductions.

Overall, the findings indicate that substantial methane reductions can be achieved through targeted interventions at a limited number of large super-emitting landfills. Prioritising investments and mitigation efforts on these highest emitting landfills through the installation of new- and the improvement of existing gas collection systems could provide a rapid and cost-effective pathway for reducing methane emissions from Brazil's waste sector.

## 2 Background

According to estimates from Brazil's Ministry of Cities (Ministério das Cidades), Brazil generated and collected approximately 78 million tonnes of municipal solid waste in 2023, of which nearly three-quarters were disposed of in sanitary landfills whilst more than 17 million tonnes of waste were still disposed of in non-sanitary controlled landfills and dumpsites. The waste sector emitted approximately 91 $MtCO_2e$ in 2022, with methane accounting for almost all waste-sector emissions. Solid waste disposal sites contribute just over half of this (53 $MtCO_2e$), of which 82.5% originated from managed sites.

Existing landfill gas collection systems already contribute significantly to methane mitigation in Brazil. According to the System for Estimating Greenhouse Gas Emissions and Removals (SEEG), approximately 581 $ktCH_4$ were recovered from 54 sanitary landfills in 2024. SEEG estimates that this recovery prevented

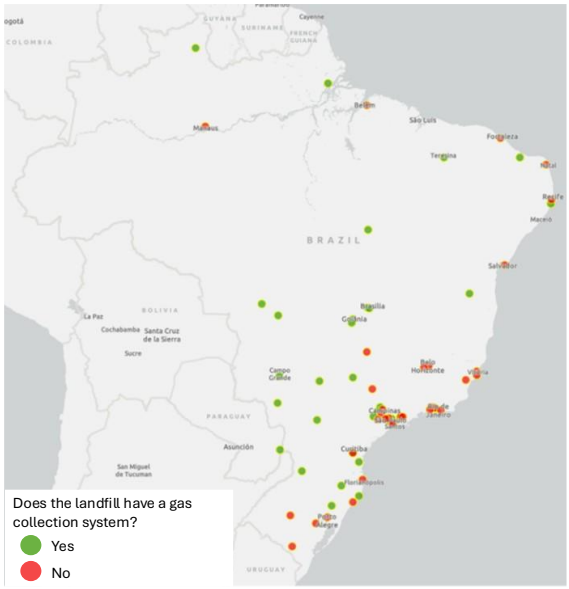
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approximately 25% of methane emissions that would otherwise have been released from waste disposal sites. However, significant uncertainties remain regarding actual emissions and the performance of existing methane management systems across the country.

The advancements in satellite-based methane monitoring have created new opportunities to identify and quantify emissions from individual landfills, providing a complementary dataset to existing landfill emission models. Satellite observations from Carbon Mapper have revealed a number of landfill methane super-emitters across Brazil, providing a means to move beyond national inventory estimates and identify specific facilities responsible for a large share of emissions and prime for mitigation action. Understanding the scale of emissions, the technically recoverable methane resource, and the associated abatement costs will help prioritise actions under Brazil's emerging Satellite Super-Emitter Initiative and direct resources toward facilities where the greatest climate benefits can be achieved.

This whitepaper presents a screening-level assessment of methane emissions, mitigation potential, and abatement costs for 66 solid waste disposal sites identified through the Carbon Mapper observations (see Figure 1). The focus of this report is downstream mitigation actions at the final disposal site, including design and management interventions that can be undertaken at sanitary landfills and dumpsites in Brazil.

Figure 1 - Map of assessed landfills with (green) and without (red) existing gas collection system




## 3 Analytical approach

The assessment integrates Carbon Mapper satellite-derived methane observations, landfill-specific operational information, first-order-decay (FOD) modelling, and economic analysis to estimate methane mitigation opportunities across the identified landfill portfolio. Specifically, the assessment evaluates:

- Annual methane emissions
- Technically recoverable methane mitigation potential
- Abatement costs associated with landfill gas collection and utilisation systems

Annual methane emissions were estimated using Carbon Mapper source emission rates in kg/hour, which were converted to kt/year, assuming observed emissions reflect annual average conditions, and used as the primary basis for the mitigation analysis. To account for measurement uncertainty, Carbon Mapper emission rates were processed using Monte Carlo uncertainty propagation before conversion to annual emissions.

In parallel, landfill-specific FOD modelling was conducted using available information on waste quantities, waste composition, landfill age, climatic conditions, and landfill gas recovery.

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While satellite observations provide estimates of actual methane emissions at the time of detection, the FOD model estimates emissions based on historical waste disposal and expected decomposition patterns. Considering these fundamental differences in estimation approaches, the FOD calculations were not used directly to estimate mitigation potential. Instead, they served as an independent reference against which the observation-based total emission estimates across the assessed sites could be compared, helping to identify discrepancies, assess the plausibility of results, and support interpretation of the findings.

The mitigation assessment was based on observed methane emissions derived from Carbon Mapper. For all sites, it was assumed that improved landfill gas management could achieve an effective methane capture efficiency of 85%, consistent with well-designed and well-operated landfill gas collection systems and representative of good industry practice. Actual collection efficiency may vary substantially among sites, and the 85% assumption should be interpreted as an ambitious good-practice target rather than typical current performance. Under this assumption, the analysis estimates the portion of currently observed methane emissions that could be avoided through either the installation of new landfill gas collection systems or the optimisation and expansion of existing infrastructure.

Abatement costs were estimated using an adapted version of the U.S. EPA Landfill Gas Energy Cost (LFGcost) model. The model was customised using Brazil-specific assumptions relating to financing conditions, inflation, taxation, electricity prices, and operating costs, and was used to estimate project capital requirements, operational expenditures, energy recovery revenues, and greenhouse gas abatement costs. Technology pathways were selected according to methane flow rate and the presence of existing gas collection infrastructure, allowing mitigation opportunities to be compared consistently across the portfolio.

The resulting emission, mitigation, and cost estimates should be interpreted as screening-level indicators designed to support landfill prioritisation and strategic decision-making. They are not intended to replace detailed site-specific engineering assessments, feasibility studies, or investment appraisals.

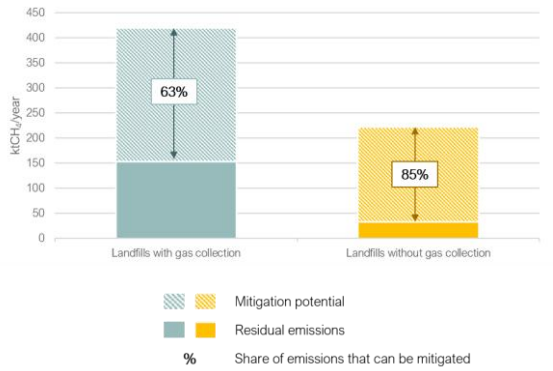
# 4 Results

The analysed landfill sites were estimated to emit approximately 642 $ktCH_4$/year, representing around 29% of methane emissions for Brazil's waste final disposal sector reported by SEEG. Emissions were more concentrated among a smaller number of large landfills and 65% of observed emissions originated from sites where landfill gas collection systems were already present.

The analysis estimated that approximately 456 $ktCH_4$/year of observed emissions could be mitigated through new or improved landfill gas collection and utilisation systems, equivalent to around 71% of observed emissions and around 20% of reported solid waste emissions for Brazil in 2024. As further shown in Figure 2, the mitigation potential for landfills without existing gas collection infrastructure is 85% of total methane emissions, corresponding to the modelled maximum methane capture efficiency. Sites that already have gas collection infrastructure in place present a mitigation potential of around 63%, indicating significant opportunities for optimisation and expansion of existing systems. This expansion or improvement of collection efficiency is highly site specific in practice and can be influenced by a variety of factors including gas collection system coverage, well density, depth and maintenance, landfill cover type and condition, leachate management, and the age and quantity of waste in place.

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Figure 2 - Mitigation potential and residual emissions[1] for landfills with and without existing gas collection systems




When comparing private- and public-owned landfills, a larger share of privately owned landfills has implemented gas collection systems (69% of private landfills) than publicly owned landfills (22% of public landfills).

**Total abatement potential**

456 $ktCH_4$/year

The economic analysis indicates that landfill methane mitigation can generally be achieved at a relatively low cost. A total of 57 out of 66 landfills exhibit abatement costs below 10 USD/$tCO_2e$, representing approximately 95% of the total mitigation potential.

The mitigation potential was estimated assuming that up to 85% of the landfill gas generated could be collected, taking into account observed methane emissions and gas volumes already being recovered. The results show that a relatively small number of landfills account for a substantial share of the total mitigation potential. The top 10 emitting sites account for 37% of total mitigation potential, while the top 20 emitting sites account for 57%. These sites also tend to have lower abatement costs, partly because larger volumes of methane can be captured at a lower cost per tonne of $CO_2e$. The weighted average abatement costs are approximately 5 USD/$tCO_2e$ for the top 10 sites and 7 USD/$tCO_2e$ for the top 20. This suggests that prioritising interventions at these sites could deliver substantial emission reductions at relatively low cost.

## 5 Implications for methane mitigation in Brazil

The results suggest that mitigation efforts could initially focus on a limited number of high-emitting landfills where substantial reductions can be achieved at comparatively low abatement costs. Prioritising these sites provides a practical starting point and can support subsequent efforts across a broader range of facilities.

Importantly, many of the largest mitigation opportunities are associated with landfills where landfill gas collection systems are already in place. The presence of collection infrastructure does not therefore mean that the available methane reduction potential has been realized. Improvements to existing systems, including expanded collection coverage, leak detection and repair, improved cover management, and operational optimisation, should therefore be considered alongside the installation of new systems.

While prioritising the lowest-cost opportunities offers a practical starting point, additional financial support may be needed to extend mitigation efforts to other landfills. Carbon market revenues, climate finance, public support and landfill gas utilisation revenues can be considered to improve project economics and support wider implementation.

Satellite observations, combined with facility-level data, emissions models, and ongoing monitoring of gas collection systems, can help identify priority sites, track mitigation progress and verify emission reductions over time. Together, these approaches can support the achievement of the targets established under Brazil's Satellite Super-Emitter Initiative.

[1] Residual emissions represent the portion of emissions remaining after the identified mitigation opportunities have been implemented.

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Finally, while the measures assessed in this study offer opportunities for near-term emission reductions, landfill methane mitigation should be part of a broader waste management strategy that also addresses waste generation and diversion from disposal.

**Key Results**

- 642 $ktCH_4$/year observed emissions
- 456 $ktCH_4$/year mitigation potential
- Top 20 emitting sites = 57% of potential
- 57 sites below 10 USD/$tCO_2e$

## 6 Conclusions

- **Targeting super-emitting landfills can deliver substantial reductions**. 71% of observed emissions could potentially be mitigated through improved landfill gas management corresponding to 20% of Brazil's reported solid waste emissions for 2024.
- **Improving existing gas collection efficiency offers significant mitigation opportunities**. Optimising and expanding existing systems can deliver substantial additional emission reductions.
- **A targeted approach can be highly cost-effective**. The top 20 sites account for 57% of mitigation potential, while 95% of the total potential is below 10 USD/$tCO_2e$.
- **Satellite observations can support action and prioritisation**. Combined with facility data and ongoing monitoring, they can help target major emission sources and track mitigation outcomes.

Overall, the findings suggest that targeted investment in high-emitting landfills, particularly through improved gas collection performance, could deliver substantial methane emission reductions in the near term at relatively low cost, while also providing environmental, public health, and energy recovery co-benefits. These efforts should be pursued alongside measures to reduce waste generation and divert organic waste from disposal, combining immediate reductions from existing landfills with longer-term efforts to prevent methane generation.

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