

SUMMARY OF FINDINGS
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**Web-Based Monitoring of Gas Emissions from Landfill Sites
using Autonomous Sensing Platforms**

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Autonomous sensor platforms were developed for long-term continuous monitoring of greenhouse gases (methane and carbon dioxide) and extraction pressure. Web-based accessibility via integrated telemetry facilitated data access and visualisation from these remote deployments. These platforms were employed principally on landfill sites, though applicability was demonstrated also for emissions from peatlands and wastewater treatment plants. The extensive wealth of data acquired enabled the analysis of gas behaviour with respect to local environmental conditions, hence leading to a greater understanding of gas dynamics. This, in turn, was more conducive to better informed decision-making and operation-practices in managing gas emissions.

Key Words: Environmental Monitoring, Remote Sensing, Greenhouse Gases, Landfill Gas.

Background:

The increased awareness of environmental monitoring as driven by international legislation has led to the development of autonomous platforms for the real-time monitoring of gases in the environment. Such monitoring is applicable to the mandatory licensing terms of landfill sites. Landfill gas is primarily comprised of methane (CH₄) and carbon dioxide (CO₂), highly potent greenhouse gases produced from the decomposition of biodegradable waste in an anaerobic environment. In addition to their global warming potential, these gases present local risks due to fire (methane is extremely flammable at 5–15% v/v concentration in air) and suffocation (air displacement by denser carbon dioxide in enclosed dwellings).

The management of landfill gas is one of the critical operations in a landfill facility, where gases are extracted and combusted in a flare or engine. Gas monitoring on-site is conducted under two motivations; firstly, periodic checks at perimeter locations to ensure against gas migration into the local environment; secondly, regular adjustment of gas flow from different sections of the site in order to maintain the optimum gas composition for combustion (field balancing). Traditionally, such monitoring involved manual measurements over expansive and difficult terrain. Consequently, measurements were taken at extended intervals and with limited spatial coverage.

Key points

- Autonomous sensor platforms have been developed for long-term monitoring of greenhouse gases. Sampling was conducted every six hours with GSM transmission enabling data access

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via an online portal. Accurate and reliable deployments have been demonstrated for up to 12 months.

- Technical developments have delivered a reliable and cost-effective platform capable of prolonged deployment duration (indefinite battery life with solar charging). Such developments are conducive to scaled-up deployments and commercial viability.
- A total of 14 autonomous sensor platforms were delivered in this project, with a cumulative of approximately 2,800 days of monitoring operation, acquiring over 7,000 gas concentration readings and 33,000 pressure level readings. These deployments involved five Irish landfill sites as designated by the EPA OEE (Office of Environmental Enforcement), one landfill site in Scotland in collaboration with consultancy Fehily Timoney & Co and a wastewater treatment plant in Brazil in collaboration with University of São Paulo, Brazil.

Findings / Recommendations

- In monitoring landfill perimeter wells, excessive gas concentrations were found to be associated with on-site extraction rate, thus providing an insight into gas behaviour at dispersed locations relative to changes in the flare/engine operation.
- Local weather conditions were found to contribute to landfill gas activity, with correlations found with respect to barometric pressure and rainfall. Tidal conditions were found to have no contribution to gas behaviour of one coastal site in question.
- Slight but appreciable levels of carbon dioxide were detected in virgin peatlands, a typical substrate upon which Irish landfills are constructed, therefore questioning the regulatory threshold limits applied to landfill perimeter wells. Analysis of the gas activity suggested that the gas generation depended on the ground moisture at the sampling locations in question.
- In monitoring in-line with the landfill extraction network, the deployed platforms exhibited consistent agreement with on-site spot checks and SCADA measurements. Potential has been demonstrated for quantifying methane generation potential at distributed locations as well as diagnosing the effectiveness of the extraction network, hence aiding field balancing and landfill gas management.
- The commercial prospect of this work has been affirmed with positive feedback from landfill operators, regulators and private consultancies.

For Further Information

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Publications connected to this work

Collins, F., Orpen, D., McNamara, E., Fay, C., and Diamond, D. Landfill Gas Monitoring Network – Development of wireless sensor network platforms. SENSORNETS 2013, Barcelona, Spain, February 2013. Accessible from <http://doras.dcu.ie/17828/>