

Economic evaluation of biofiltration technologies for emissions mitigation from aftercare landfill sites

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Keywords: cost benefit analysis, biofiltration, externalities, landfill gas

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An economic evaluation regarding the use of the biofiltration systems for the management of low levels of landfill gas is the objective of this study.

LIFE RE Mida project aims to promote the environmental and economical sustainability of biofiltration systems for the biological oxidation of low levels of landfill gas. In this frame, two full-scale biofiltration systems were built and a monitoring and control plan helped to assess the performance of the systems. An active biofilter was built at Podere il Pero landfill, managed by CSAI S.p.A, located in the province of Arezzo and seven passive biofilter on many emissive hot-spots were built at Le Fornaci di Monticiano, managed by Sienambiente S.p.A located in the province of Siena.

The performance of the biofiltration systems regarding the methane oxidation efficiency and the NMVOCs and odorous compounds abatement are high (Pecorini et al., 2017), but is necessary to perform a Cost-Benefit Analysis (CBA) to compare different landfill gas (LFG) control measures to find the most cost-effective approach, and evaluate the economical sustainability of biofiltration technologies.

The CBA is carried out according to the technical reference standards (*European Commission, 2017*). At first was defined the goal of the assessment: the economic comparison between different LFG management strategies for a landfill in the aftercare phase, with reference to the after-care management phase with a duration of 50 years. Secondly, was made an inventory Analysis, four alternative management and treatment scenarios were modelled in Excel. In the *Scenario 0*, LFG is emitted directly through the top cover, typical of a landfill closed before the entry in force of the Italian regulation (D. Lgs 36/2003) and without an active extraction system; *Scenario 3*, alternative to the previous one, which uses a passive biofiltration system (Biowindows) installed as an addition to the final coverage system. *Scenario 1*, which considered a landfill closed after the entry in force of d. Lgs. 36/2003, where the gas is collected and burnt in internal combustion engines (ICE) and flares, but when the LFG energy content is not enough to sustain combustion, additional fuel, natural gas, is added; *Scenario 2*, alternative to the previous one, the use of thermal treatments is integrated with the use of an active biofiltration system (biofilter), with the aim of not using additional fuel. The efficiency of the LFG extraction was set constantly at 75% before the beginning of the aftercare phase. (Damgaard et al (2011), Turner et al (2016)). Furthermore, the study compared the results regarding three different types of landfills: *Big Landfill* (200.000 m²), *Medium Landfill* (50.000 m²), *Small Landfill* (20.000 m²). The third step was the Economic Analysis, in which for each management year the cash flow was structured, i.e. the difference between the costs and the benefits. Then the annual cash flow was discounted according to the model of Net Present Value (NPV). The sum of all the annual NPV returns the accumulated NPV. Externalities regarding the four scenarios were evaluated (ExternE (1995), Krewitt et al (1998), and Eshet et al (2006), Nahman (2011)) considering the impact pathway methodology defined by European Commission DG Environment (2000).

In the study, the comparison of the results regarding the three scenarios is divided in two parts: *Scenario 1 vs Scenario 2* (considering only *Big Landfill* and *Medium Landfill*) and *Scenario 0 vs Scenario 3* (considering only *Medium Landfill* and *Small Landfill*). The best scenario is represented by the one with the highest cumulated NPV.

In general, the results of the economic evaluation show an improvement in the scenarios in which the use of biofiltration systems is considered. The best results emerged for the comparison of the *Scenario 0 vs Scenario 3*, with a value equal to -33.60% in the case of *Medium Landfill* and 60.87% in the case of *Small Landfill*.

Acknowledgements

LIFE RE Mida project (LIFE 14 CCM/IT/000464) is co-funded by LIFE Climate Action - Climate Change Mitigation.

The authors want to thank the partners CSAI S.p.A and Sienambiente S.p.A for the technical support provided.

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