

Accepted Manuscript

Greenhouse gas emissions from different sewage sludge treatment methods in north

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PII: S0959-6526(17)33222-5

DOI: [10.1016/j.jclepro.2017.12.232](https://doi.org/10.1016/j.jclepro.2017.12.232)

Reference: JCLP 11627

To appear in: *Journal of Cleaner Production*

Received Date: 2 July 2017

Revised Date: 23 December 2017

Accepted Date: 26 December 2017

Please cite this article as: Piippo S, Lauronen M, Postila H, Greenhouse gas emissions from different sewage sludge treatment methods in north, *Journal of Cleaner Production* (2018), doi: 10.1016/j.jclepro.2017.12.232.

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1 7617 words

2 **Greenhouse gas emissions from different sewage sludge treatment methods in**
3 **north**

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10

11 **Abstract**

12 The most sustainable method for treating sewage sludge depends strongly on the situation and local
13 circumstances. In sparsely populated northerly areas are demanding boundary conditions, e.g. cold
14 and long winter, long transport distances and low amounts of generated sludge. In this study,
15 commonly used calculators and emissions coefficients for calculating the greenhouse gas (GHG)
16 emissions from sewage sludge treatment methods were assessed to create a calculator suitable for
17 the Northern Finland context. The calculator was then used to determine which sewage sludge
18 treatment method (composting, anaerobic digestion (AD), incineration (with and without thermal
19 drying)) resulted in the lowest emissions of the GHG gases in different situations in Northern
20 Finland. GHG gases included carbon dioxide (CO₂; including biobased), methane (CH₄) and nitrous
21 oxide (N₂O), measured as carbon dioxide equivalents (CO₂eq). According to the calculator, AD
22 generated the least CO₂eq emissions of all treatment methods studied. The second best option was
23 incineration of sludge without thermal drying, while the third best was composting or incineration
24 of sludge after thermal drying with e.g. fossil or other fuels. Most of the emissions were generated
25 from the treatment process itself and the share of emissions generated during transport was
26 minimal, despite the long transport distances when all CO₂ emissions (incl. biobased) were
27 considered. The role of users of the end-products and the possibility to use the CO₂ generated were
28 highly important when considering environmental perspective. These results can be utilized when
29 selecting the locally most suitable method. In future, some of the treatment methods (i.e. AD,
30 incineration) with CO₂ capture could be considered carbon sinks, as they also remove biobased CO₂
31 emissions.

32

33 **Keywords:** greenhouse gas emissions; carbon dioxide equivalent; sewage sludge treatment; north;
34 calculator

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