Allegato 2

Science of the Total Environment 693 (2019) 133516

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Environmental and economic implications of recovering resources from food waste in a circular economy

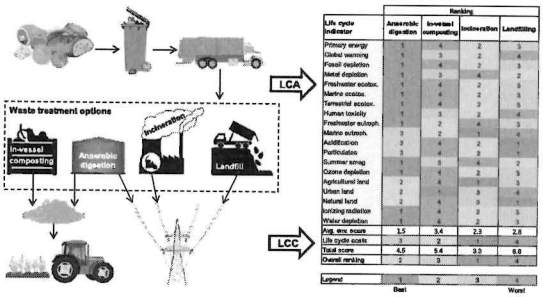
Peter C. Slorach, Harish K. Jeswani, Rosa Cuéllar-Franca, Adisa Azapagic *

Sustainable Industrial Systems, School of Chemical Engineering and Analytical Science, The University of Manchester, Manchester M13 9PL, UK

HIGHLIGHTS

- Anaerobic digestion, in-vessel composting, incineration and landfill are considered.
- Incineration is currently the most sustainable option per tonne of waste treated.
- Anaerobic digestion is the best option based on the annual volume of waste treated.
- Treating waste by anaerobic digestion could save annually £251 m and 490 kt CO_2 eq.
- Far greater environmental and cost savings would be gained through waste avoidance.

GRAPHICAL ABSTRACT



Life cycle indicator	Ranking: Anaerobic digestion	In-vessel composting	Incineration	Landfilling
Primary energy	1	4	2	3
Global warming	1	3	2	4
Fossil depletion	1	4	2	3
Metal depletion	1	3	4	2
Freshwater ecotox.	1	4	2	3
Marine ecotox.	1	4	2	3
Terrestrial ecotox.	1	4	2	3
Human toxicity	1	3	2	4
Freshwater eutroph.	1	2	4	3
Marine eutroph.	3	2	1	4
Acidification	2	4	2	1
Particulates	3	4	2	1
Summer smog	1	3	4	2
Ozone depletion	1	4	2	3
Agricultural land	2	4	3	1
Urban land	2	1	3	4
Natural land	2	4	3	1
Ionising radiation	1	4	2	3
Water depletion	1	4	2	3
Avg. env. score	1.5	3.4	2.3	2.8
Life cycle costs	3	2	1	4
Total score	4.5	5.4	3.3	6.8
Overall ranking	2	3	1	4
Legend	1 Best	2	3	4 Worst

ARTICLE INFO

Article history:
Received 22 June 2019
Received in revised form 19 July 2019
Accepted 19 July 2019
Available online 20 July 2019

Editor: Damia Barcelo

Keywords:
Climate change
Costs
Environmental impacts
Food
Sustainability assessment
Waste treatment

ABSTRACT

Around a third of food is wasted globally, requiring significant resources for its treatment and disposal, in addition to wasting valuable resources. Following the circular economy principles, this waste should ideally be avoided, and if not possible, treated to recover resources. This paper considers the life cycle environmental and economic implications of recovering energy and material resources from food waste, focusing on the UK situation. Four treatment methods are considered: anaerobic digestion, in-vessel composting, incineration and landfilling. The results show that per tonne of waste treated, anaerobic digestion has the lowest environmental impacts in 13 out of the 19 categories considered in the study, including net-negative global warming potential. In-vessel composting is the least sustainable option environmentally, in contrast to being preferred over incineration according to the circular economy principles. Incineration has the lowest life cycle costs (£71/t), while landfilling is the costliest option (£123/t). Managing the 4.9 Mt of food waste collected annually from UK households via the four methods generates 340,000 t CO_2 eq. and costs £452 m, in addition to causing a number of other environmental impacts. However, it also saves 1.9 PJ of primary energy, primarily due to electricity generation through incineration. If all of this food waste was incinerated, £103 m and 360,000 t CO_2 eq./year could be saved compared to current waste management, rendering incineration a carbon-negative technology. This would also result in savings in 14 other impacts, but would increase summer smog by 30% and metal depletion by 56%. The environmental benefits of incineration would be exceeded only if all food waste was treated by anaerobic digestion, which would save 490,000 t CO_2 eq./year and produce 50% more electricity per tonne of waste than incineration. Anaerobic digestion would also lead to savings in 14 other impacts compared to the present situation, but would result in a four times higher acidification and three times greater emissions of particulate matter. In addition, it would save £251 m/year compared to the current costs. Nevertheless, prevention of avoidable food waste would realise far greater environmental and economic savings, estimated here at 14 Mt CO_2 eq. and £10.7 bn annually.

* Corresponding author.
E-mail address: adisa.azapagic@manchester.ac.uk (A. Azapagic).

https://doi.org/10.1016/j.scitotenv.2019.07.322