FICHTNER
Consulting Engineers Limited

Zero Waste Scotland Technical Report

Environmental Services Association

Technical Note

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Contents

1 Introduction

The Zero Waste Scotland (ZWS) Technical Report '*The climate change impacts of burning municipal waste in Scotland*' was published in October 2020. The report assesses the climate change impacts of burning residual municipal waste in Scotland by calculating the carbon intensity and greenhouse gas (GHG) emissions of six Energy from Waste (EfW) plants in 2018 in Scotland. The net GHG emissions per tonne of waste processed have been calculated using life cycle analysis for both EfW and landfill as an alternative waste management option.

Fichtner has been engaged by the Environmental Services Association (ESA) to develop a short technical note which provides commentary on specific aspects of the recent ZWS report. In particular, while the report is clearly set out and includes a life cycle assessment, we consider that there are two problems with the life cycle assessment which lead to inaccurate results. We also consider that comparing the carbon intensity of energy from waste plants with conventional power generation plants is potentially misleading.

In this note, we have concentrated on the comparison between landfill and the three conventional energy-from-waste plants. This is because the two gasification plants were not fully operational during the period considered and so were diverting waste to other EfW plants; and the heat only plant is much smaller and situated on an island, so is unlikely to be representative of other plants.

2 Life cycle assessment

2.1 Benefit assigned to pre-recycling of waste

The report assigns additional carbon benefits to the pre-treatment for recycling of materials prior to incineration or disposal in a landfill. The report states that "about 10% of waste sent to landfill is sorted for recycling" (based on 2018 site returns data from a representative landfill site) and as a result carbon savings from recycled materials were estimated to be 84 kgCO_2e/tonne of waste processed in a landfill (using carbon factors from the Scottish Carbon Metric). The equivalent figures for the three conventional energy from waste plants considered are 14, 78 and 20 kgCO_2e/tonne of waste for plants EOP1, EOP2 and EOP3 respectively, with an average of 37.3 kgCO_2e/tonne of waste. However, these figures include a contribution for metals recovered from the bottom ash, so the contribution from the pre-treatment of waste will be lower than this.

We suspect that this apparently poorer performance is because plants EOP1 and EOP3 do not include on-site recycling facilities. It is our understanding that these facilities manage their feedstock in line with SEPA's Thermal Treatment of Waste Guidelines by accepting a pre-processed residual waste, where recyclates have been removed in a pre-treatment facility (either offsite or, in one case, adjacent to the site) or via a robust source segregation collection service, so that only residual waste is processed within the waste incineration plant.

We consider that allowing extra benefit for the pre-treatment of the waste to remove recyclates puts an unfair disadvantage on those facilities which arrange for the recyclates to be removed off-site. It is also illogical, as it means that an EfW plant with an on-site pre-treatment plant performs much better than an EfW plant where pre-treatment is undertaken off-site, or where the waste is segregated at source.

2.2 Energy displacement from landfill calculations

The report states, in Table 6, that electricity generated from the collection of landfill gas displaces 122 $kgCO_2e$/tonne of waste; and the report states in table 5, that electricity generated from the combustion of waste in a conventional energy from waste plant displaces 97-127 $kgCO_2e$/tonne of waste. However, energy-from-waste plants generate considerably more electricity than landfill sites per tonne of waste, so these figures cannot be right.

We consider that the problem is equation 3 in the report:

$$\begin{aligned} &Power\ generated\ per\ tonne\ of\ waste\ landfilled \\ &= Volume\ of\ methane\ captured\ and\ burnt \\ &\times Density\ of\ gas\ \times NCV\ of\ gas \end{aligned}$$

This equation correctly calculates the total energy in the landfill gas used to generate electricity. However, not all of this energy is converted to electricity. The equation should take into account the efficiency of the landfill gas engine, which is typically around 36%[1]. This means that the benefit from energy displacement should be approximately 44 $kgCO_2e$/tonne.

2.3 Effect on the report conclusions

The report concludes that sending one tonne of residual municipal waste to an electricity-only conventional EfW in Scotland in 2018 emitted an average 227 $kgCO_2e$ compared to 257 $kgCO_2e$ per tonne for a landfill. Therefore, processing waste in an EfW resulted in approximately 12% less GHG emissions.

If the extra carbon benefit from the pre-treatment of waste (including metals recovery) is removed for both scenarios, the emissions are calculated at approximately 282 $kgCO_2e$ per tonne of waste processed for EfW and approximately 341 $kgCO_2e$ per tonne of waste processed for landfill. If the error in energy displacement for landfill is corrected, the emissions increase to around 419 $kgCO_2e$ per tonne of waste processed for landfill. Therefore, we consider that processing waste in an EfW will result in approximately 33% less GHG emissions than disposal of the equivalent waste in a landfill, assuming that all the other assumptions in the ZWS report are correct.

3 Carbon Intensity

The comments above have focussed on the life cycle assessment calculations in section 3.2 of the ZWS report. The report also comments on the carbon intensity of power generation from energy-from-waste plants and compares this to the carbon intensity of other forms of power generation.

However, this comparison is not reasonable. An energy-from-waste plant serves two purposes – it generates electricity and it processes residual waste, avoiding landfill. Other forms of power generation do not process residual waste. Therefore, for a fair comparison with other forms of power generation, energy from waste plants should be given a credit for the avoided greenhouse gas emissions from landfill. This approach is taken in the life cycle assessment part of the report, so it is misleading to also quote carbon intensity figures which ignore the displacement of landfill.

[1] DEFRA – Review of landfill methane emissions modelling (2014)

4 Conclusion

We consider that ZWS should recalculate the life cycle assessment in the manner discussed above and republish the report.

We also consider that the report should not report the simple carbon intensity of power from EfW plants, as this is misleading. The carbon intensity should be calculated by giving a credit for the displacement of landfill, or the report should focus on the life cycle assessment.

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FICHTNER

Consulting Engineers Limited

Kingsgate (Floor 3), Wellington Road North,
Stockport, Cheshire, SK4 1LW,
United Kingdom

t: +44 (0)161 476 0032
f: +44 (0)161 474 0618

www.fichtner.co.uk