Fact sheet
November 2022

Emissions impacts of food waste recovery technologies

There are a range of technologies and systems available for processing household kerbside food organics and gardens organics (FOGO) and food only waste from business. This fact sheet describes and compares the greenhouse gas emission profiles of these management options.

Introduction

This fact sheet is one of a series analysing the emissions impacts of different processing technologies for food waste in NSW. It summarises the findings of the modelling. Separate fact sheets in this series describe in more detail individual management options and the components contributing to net greenhouse gas (GHG) emissions.

GHG emissions are just one of many factors in choosing a suitable food waste management option for a particular location.

The options for food waste management in NSW include on-site dehydration and bio-dehydration units, commercial composting, vermi-composting, anaerobic digestion with energy recovery, and protein farming using insect larvae to convert food into stockfeed protein.

Landfill

Until recently, landfill disposal was the most common waste management option for food waste, which was disposed of in the general 'red lid' bin. Food degrades rapidly in landfill and generates methane, a potent GHG. Some larger sites capture landfill gas to generate electricity. This has the benefit of oxidising the methane so it no longer acts as a GHG, offsets non-renewable power and reduces fossil fuel emissions. Unfortunately, because food degrades rapidly, landfill gas and energy recovery systems are often installed after most of the GHG from food waste have already been emitted.

This means, once gas recovery systems are in place even landfills achieving high levels of gas capture do not capture enough methane from food to sufficiently offset emissions from the degradation of food waste.

The modelling found that even high gas capture and electricity generating landfills can be expected to generate methane with a global warming potential of around 550 kilograms carbon dioxide equivalents (CO_2-e) per tonne of food landfilled. Other food waste management scenarios have been compared against this benchmark.

On-site composting and vermi-composting

On-site composting and 'worm farms' can be used where sites have sufficient space and resources to manage the quantities of food waste they generate. This can range from small domestic 'compost bin' scale management to larger mechanised on-site units. The main advantage of on-site management is to avoid collection and transport costs, traffic, and emissions, but systems need space and to be well managed to avoid significant GHG emissions, odour, pest animals and insects and potential water pollution.

Off-site composting

Composting off-site is a common option for source separated food waste. The main commercial composting options are turned windrow and aerated pile/ in-vessel composting. Figure 1 shows that net GHG emissions from off-site composting are much lower than landfill, but higher than options that also generate energy.

Open windrow systems are typically higher emitters of GHG than aerated composting systems due to higher fuel use for windrow turners, and greater risk of fugitive methane and nitrous oxide. Aerated pile and in-vessel systems can reduce their carbon footprint by using renewable or other low emissions power to run the aeration systems.

The soil carbon sequestration benefits of compost will depend on the nature of organic outputs and how they are used. More stable compost products will have greater soil sequestration benefits than immature organic outputs. Most composts are used as a soil conditioner rather than as a direct fertiliser substitution so the GHG benefits of synthetic fertiliser reduction (in the order of 20 kg CO_2e per tonne of wet food waste) has not been included in the modelling.

Off-site anaerobic digestion (AD)

AD biogas energy recovery systems that offset power from fossil fuels can result in a net reduction in GHG emissions. The modelling (Figure 1) suggests that other than protein farming where insect larvae-derived protein is assumed to result in decreased other sources of protein production, sending food to AD biogas energy recovery results in the best GHG emissions outcome compared to other management options. However, the benefits of energy offsets can be expected to decline over time when a higher proportion of grid power in NSW is supplied from renewable and other low emissions sources.

On-site dehydration and bio-dehydration

Dehydration units dry food into a friable ‘flake’ that in some situations may be managed on-site, but more typically in NSW needs to be applied to land in compliance with a specific Resource Recovery Order and Exemption, or taken to an off-site secondary processor. Bio-dehydration technologies use biological agents to partially decompose and stabilise food.

The main advantages of these systems are that they reduce the weight and volume of food organics needing to be collected and transported. In addition, they reduce the odour potential of the food waste.

The main limitation of these systems is their relatively high energy use and corresponding carbon footprint if fossil fuel power is used. The efficiencies of units vary according to the type, scale, and use of technologies. Figure 1 shows net emissions from such units can be high if they are powered by fossil fuel sourced electricity. It is suggested that those considering using these systems investigate how much power they use, how they could be used more efficiently, and purchasing 100% renewable energy to power them.

Protein farming

A new food waste management option available in NSW is the conversion of food waste to protein for animal feed using insect larvae. Service providers can either collect food for processing at centralised facilities or install and maintain fully enclosed protein farm units at sites that generate large amounts of food.

The modelling suggests that protein farming can have significant GHG benefits if the harvested insect larvae protein substitutes for other protein, particularly mammalian protein production.

The extent to which this is the case at the current scale of operation is uncertain as most other animal protein in stock feed is derived from by-products of meat processing, rather than being raised specifically to provide stock feed.

If protein substitution is removed from the modelling the net emissions is 499 rather than -2,520 kg CO_2e/tonne of food waste.

Key findings

Assessment and modelling of these options found:

- Emissions from collection and transport of food waste off-site are usually a minor component of the net emissions.
- Even landfills with high levels of gas energy recovery still have significant net emissions from food waste because food rapidly decomposes and emits methane before the gas recovery systems are in place.
- Options that recover biogas energy using anaerobic digestion systems can have net reductions in GHG emissions if the energy substitutes for fossil fuel power.
- Protein farming using insect larvae has potential to significantly reduce net GHG emissions if the harvested protein substitutes for other protein, particularly mammalian protein. This benefit is uncertain as the protein may add to total protein production rather than replace other sources. Without this benefit, the energy use in protein farming will result in a high carbon footprint unless units are powered by renewable or lower emissions energy.
- Similarly, dehydration and bio-dehydration systems can have a high carbon footprint unless they are powered by renewable or low emissions energy sources.
- Composting can be expected to be a low, but overall net producer of GHG emissions unless the compost outputs result in greater soil carbon sequestration than modelled or result in less use of synthetic fertiliser.

It should be noted that food waste avoidance is the most effective strategy for reducing GHG and other pollution impacts of wasted food. This can also reduce the 'upstream environmental impacts of producing, processing, and distributing food. Source separation of food waste often triggers realisation of the amount and types of food waste being generated and food waste avoidance actions.

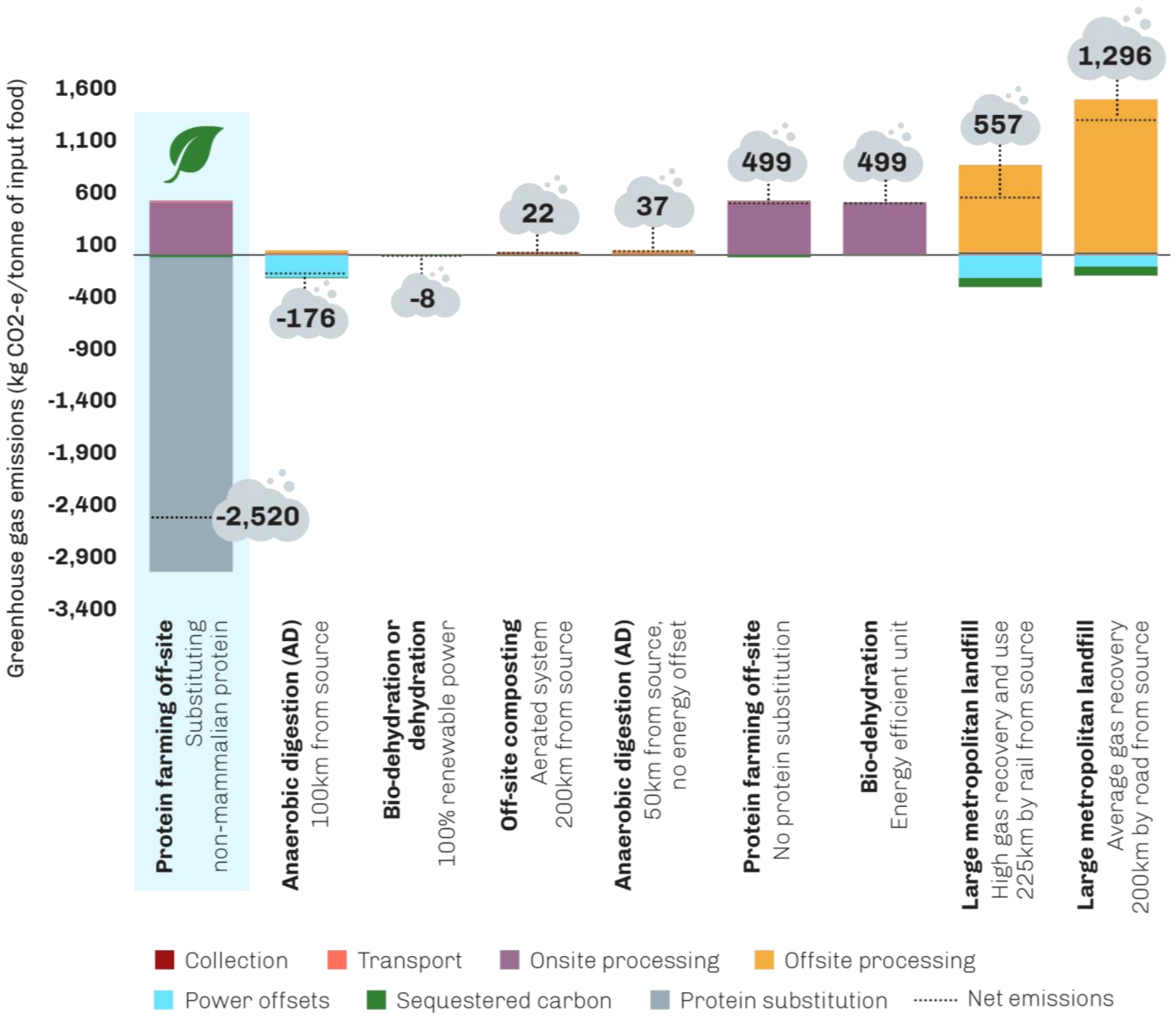

Figure 1 Comparison of emissions and offsets from different food waste management systems

Figure 1 shows that food waste to landfill generates significant net GHG emissions compared to other management options. It also illustrates the potential benefit of protein farming if the protein substitutes for other protein production.

References

Blue Environment, 2021, Organics processing technology assessment.

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