# Are landfills worse than incinerators for the climate?

An October 2023 report by the U.S. Environmental Protection Agency brought the role of methane production from landfills back into focus.[1] Its conclusions state:

- *"An estimated 58 percent of the fugitive methane emissions (i.e., those released to the atmosphere) from municipal solid waste landfills are from landfilled food waste."*
- *"An estimated 61 percent of methane generated by landfilled food waste is not captured by landfill gas collection systems and is released to the atmosphere. Because food waste decays relatively quickly, its emissions often occur before landfill gas collection systems are installed or expanded."*

Clearly, landfills are a global warming problem, and it's important to aerobically compost source-separated food and yard waste to keep them out of landfills. However, there is still a lot of organic waste that is not separated for composting. Is it better to burn this trash and landfill ash, or it directly landfilling it still the lesser evil?

As it turns out, **incinerators are still worse than landfills in terms of their climate impacts, and when other health and environmental factors are considered, incinerators are much worse than landfills.**

One reason for this is that trash is much more than food scraps. When food scraps hit the trash can, they are mixed with plastics, paper, metal, glass, and other materials. In an incinerator, all of the carbon is immediately injected into the atmosphere, almost entirely in the form of $CO_2$. In landfills, much of the carbon is in materials that do not readily break down, like plastics, wood, leather, and to some degree, paper products. That carbon ends up being sequestered in the landfill for a long time, even while the easily degradable organics (food scraps and yard waste) break down and form landfill gas, which is roughly half methane and half $CO_2$.

This was documented in a comprehensive life cycle assessment (LCA) study commissioned by Delaware County, Pennsylvania as part of their Zero Waste Plan.[2] That LCA looks at using the nation's largest trash incinerator (Covanta Delaware Valley in the City of Chester, PA) vs. their county-owned Rolling Hills Landfill.

In the first chart below, the first three bars represent different gas capture rates at Rolling Hills Landfill – 70%, 30%, and 0% (no gas capture). 75% is a standard assumption by EPA and the waste industry, so even the 70% figure in this analysis was a bit conservative.

The LCA was done using the Measuring Environmental Benefits Calculator (MEBCalc™), which is the most comprehensive LCA tool for waste systems. MEBCalc outputs cover nine different human and environmental health impacts, ranging from global climate health to local human health. Monetization in terms of environmental economic value (EEV) for each impact enables comparison among impact costs, as well as calculation of a single indicator of overall EEV costs of MSW disposal so that decision-makers can fairly compare these health and environmental externalities.

The black bar in the charts represents climate impacts from greenhouse gas emissions, primarily methane and carbon dioxide ($CO_2$). The grey represents local impacts such as nitrogen oxides that trigger asthma attacks, toxic chemicals that cause cancer and birth defects, and particulate matter that contributes to heart attacks, stroke, and more. The red lines represent transportation emissions from trash trucks that pick up the waste and drop it off at a transfer station, while yellow represents the long-haul transfer trailer trucks that haul from the transfer station to the incinerator or landfill.

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[1] U.S. Environmental Protection Agency, "Quantifying Methane Emissions from Landfilled Food Waste," Oct. 2023. www.epa.gov/land-research/quantifying-methane-emissions-landfilled-food-waste

[2] Delaware County's Path to Zero Waste, June 2023. https://drive.google.com/file/d/1hfS1iYZhTYz2yzTK6zZ8M6KlQ37hPFxB/ See life cycle analysis summary starting on p.64, and the full 50-page life cycle assessment in the final Appendix, which starts on p.166 of the PDF. The chart below is from p.69 as well as pages 8 and 33 of Appendix I.

EPA's report states that 61% of the methane generated by landfilled food waste is not captured by landfill gas collection systems and is released to the atmosphere, which means there's a capture rate of around 40% for food waste. Because other materials that form methane would do so slower than food waste does, the overall landfill gas capture rate can be assumed to be something above 40%.

The chart below shows that, at a 30% capture rate, GHG emissions from landfilling result in a climate cost of about $225 per ton of waste disposed, pretty much equal to the GHG emissions from incineration which total around $230/ton. A 40% capture rate would equate to about $200/ton in landfill climate costs. A 50% capture rate, which would start to account for the fact that not all methane generation in landfills is from quickly-degrading food scraps, equates to about $174/ton in landfill climate costs… far less than the $230/ton from incineration.

Enter offsets. In life cycle assessments, it's typical to subtract emissions from energy generation that is presumed to be displaced by the energy generation from an incinerator or landfill. Trash incinerators do not generate much power compared to most power plants, but they generate far more than landfills that burn their gas for energy. About 2/3rds of the operating trash incinerators in the U.S. are located in states where their power can be sold into a state renewable portfolio standard (RPS) program. RPS laws are mandates for utilities to buy a certain percentage (increasing over time) of "renewable" energy. Most of these laws count trash burning as renewable, even though trash incineration is more polluting than burning coal by most measures including climate impacts, where trash burning emits 65% more carbon dioxide to make the same amount of energy as coal burning. Where trash incinerators compete within an RPS program, it is inappropriate to assume they are displacing fossil fuels because the utilities, if not purchasing renewable energy credits from the incinerator, would have to purchase them from another renewable source, typically wind power. In these cases, there are no offsets. However, in situations where the incinerator is not selling renewable energy credits into a state RPS program, it can be assumed that they are displacing energy generation that would be used for peaking power – typically natural gas. The MEBCalc LCA for the Covanta incinerator in Delaware County, PA found that the climate costs are around $171/ton after subtracting for displaced gas-fired power production, as well as subtracting for offsets from metals recycled out of the incinerator ash (that displace the need for new metal production).

Another offset typically used in LCAs is to assume that the "biogenic" portion of the $CO_2$ emissions from an incinerator do not count because plants and trees regrow to make food, paper, wood, and other materials in the waste stream that are of plant or animal origin. However, this "biomass carbon neutrality" argument has been debunked since at least 2009 by climate scientists who argue that it's double counting, as climate models already assume new plant growth. It's also inappropriate because it takes centuries for new plant growth to draw down the carbon emissions to "neutral" levels – time we do not have to avoid global warming impacts. MEBCalc does not provide this discount for the above-stated reasons, and also because the choice of using a landfill vs. an incinerator has no impact on whether plants and trees are regrowing or are replanted, meaning that any discount would be applied to both, making such an offset meaningless.

All told, at most incinerators, where fossil fuels are not being displaced because they sell into renewable energy markets, incinerators are significantly worse than landfills for the climate. Where they do not compete with renewables, the climate impacts are close and the result will depend on the proportion of methane that is attributable to food scraps, and the resulting gas capture rate. However, even if landfills turned out to be slightly worse for the climate in these situations, the other health and environmental impacts of incineration will still put the harms of incineration far above those of landfilling.