

Landfills are bad, but incinerators (with ash dumped in landfills) are worse.

Incinerators do not avoid landfills. For every 100 tons of trash burned, 30 tons become toxic ash that goes to landfills. The other 70 tons don't turn into energy, but become air pollution. In terms of air pollution, and groundwater impacts, burning waste then burying ash is far worse than direct landfilling, and both are worse than a Zero Waste approach.¹

A Zero Waste approach means zero incineration and at least 90% reduction from landfilling, with residuals biologically stabilized prior to landfilling, to minimize odors, leachate, gas formation and toxic migration.

The most recent data comparing incinerators to landfills is from air emissions data provided by the Pennsylvania Department of Environmental Protection (DEP). For 2017, this includes data on all six trash incinerators in PA and 17 landfills in DEP's southeast and southcentral regions.

Pollutant (all data in tons)	Incinerators	Landfills	Incinerators are __ times as polluting
<u>Greenhouse Gases (CO2e)</u>	482,770	268,763	<u>1.8</u>
<u>Total Health Damaging Pollution</u>	1,975	1,236	<u>1.6</u>
Carbon Monoxide (CO)	119	22	5
Hydrochloric Acid (HCl)	17	1	21
Nitrogen Oxides (NOx)	625	6	105
Particulate Matter, Condensable	25	1	17
Particulate Matter (PM10)	26	17	1.6
Fine Particulate Matter (PM2.5)	17	4	5
Sulfur Oxides (SOx)	55	3	19
Total Suspended Particulate (TSP)	2,178	2,486	0.88
Volatile Organic Compounds (VOC)	3	9	0.34

This shows that incineration is 80% worse than landfills for the climate, and that other pollutants that directly harm human health are 60% worse from incineration. Emissions of nitrogen oxides that trigger asthma attacks are 105 times as bad as landfills.

Only two pollutants for which there was complete data showed landfills to be worse: VOCs, and TSP. However the TSP average for landfills is higher only because of one facility (Fairless Landfill) that had an unusually high number. Without that data point, the average of the other landfills is just 536 tons, which means that incineration is 4 times as polluting as these other landfills, on average. The volume accepted at the landfills is about the same (just 1.6% more) than the incinerators, so this pollution difference is not a function of the amount of waste received.

A more rigorous life cycle analysis of incineration vs. landfilling was commissioned in 2017 to look at Washington, DC's waste options. It looked at DC trucking waste to the Covanta Fairfax incinerator vs. four landfills in southeastern Virginia, one of which requires trucking waste twice as far; the other three involve trucking waste four times as far. It was analyzed on the basis of pollution impacts per ton of waste disposed.

¹ See www.zwia.org/standards/zw-definition/ and www.zwia.org/zwh or www.energyjustice.net/zerowaste/hierarchy

It found that trucking emissions were insignificant compared to the emissions of the incinerators and landfills themselves. It concluded that incineration is worse than landfilling for global warming, smog, toxic emissions, acid gas emissions, nitrogen oxide emissions, and particulate matter, even when trucking waste four times as far to landfills. On one measure, eutrophication, they were basically tied. On three of the smallest measures, landfills showed to be worse. On balance, incineration was far worse than landfilling. Because it couldn't easily be quantified, dioxin emissions (the most toxic chemicals known to science, largely emitted by incinerators) and toxic leaching from incinerator ash were not accounted for. Could they be quantified, this would weigh even more heavily against incinerators.²

Why are incinerators worse?

On toxic emissions, nitrogen oxides, smog, acid gases, and particulate matter emissions, it's rather obvious. Incinerators turn 70% of the tonnage into air emissions, only some of which can be captured or reduced through air pollution control devices. Most of this is not generated at landfills because they're products of combustion. The sheer volume of material being emitted through the smokestack leads to this outcome.

Regarding toxicity, incineration is worse than landfilling for two reasons:

- 1) Highly-toxic new chemicals like dioxins/furans, and polycyclic aromatic hydrocarbons (PAHs) are formed in the combustion process and end up in the air and ash.
- 2) Toxic materials already present in products, such as toxic metals in inks or electronics, are largely trapped in the product and stay stored in the landfill long-term. When burned, those toxic metals are immediately freed and released in a form that is more available for people to eventually breathe or drink. What does not end up ejected into the air becomes part of the ash. Ash can be kicked up and blow into communities during shipping, when placed on landfills as landfill cover, and where "recycled" to make internal roads in landfills. In terms of leachate, think of coffee beans vs. coffee grounds. Pour water over beans and you won't get coffee, but grind them up and increase their surface area, pour water over them, and you get coffee. Ash is similar in that its higher surface area means more toxic chemicals can leach out, polluting groundwater.

What about methane and global warming?

Landfills *are* bad for global warming, as they emit large amounts of landfill gas as organics like food scraps and yard waste rapidly degrade. Landfill gas is about half carbon dioxide and half methane. Methane was long thought to be just about 20-some times as bad as CO₂ for the climate, but is now understood to be 34 times as bad over a 100-year time span, and a whopping 86 times as bad over a 20-year horizon, which is more relevant for avoiding global warming tipping points. Even using the latest science on methane and a 20-year time horizon, the 2017 life-cycle analysis found that trucking waste four times as far to a landfill is still not as bad for the climate as burning closer to home.

According to EPA, about half (47.3%) of the carbon in municipal solid waste is from plastics and tires.³ In a landfill, this carbon is sequestered, but when burned, it's immediately injected into the atmosphere. No carbon capture and sequestration is viable or used on trash incinerators. Carbon in more durable materials

² http://www.energyjustice.net/files/md/montgomery/incineration_vs_landfills.pdf See slides 26-59; study conclusions are on slides 38-48. Note that the difference between the red and blue lines are between doubling the trucking distance and quadrupling the trucking distance. If trucking emissions were significant, there would be a larger difference between these lines.

³ U.S. EPA Emissions & Generation Resource Integrated Database (eGRID) 2012 Technical Support Document, Table 3-2.

like wood, leather, and textiles in a landfill largely is sequestered as well, but would be emitted immediately as CO₂ if burned.⁴ It's primarily the food scraps and yard waste that degrade rapidly in a landfill, forming landfill gas. Most of that gas is captured and reduced to CO₂ when burned. Some of the methane that leaks out, uncaptured, oxidizes to CO₂, anyway. All told, even with the high potency of methane, overall climate impacts from incineration are worse for the aforementioned reasons.

EPA's WARM Model and other flawed analyses

Greenhouse gas comparisons that make incineration out to be better than landfills (or coal) rely on some major flawed assumptions.⁵ About half of the CO₂ emissions from trash incineration are considered "biogenic" in that they come from burning food scraps, yard waste, wood, paper, and other products that were grown, as opposed to petroleum-based plastics that produce the other half. While it's been scientifically debunked repeatedly, some still embrace the "carbon neutrality" argument that counts those emissions as zero because new growing plants suck up the carbon.⁶ However, the decision to burn or bury has no impact on whether plants will regrow, and it's not valid to discount nearly half of an incinerator's GHG emissions while counting the GHG emissions from landfills, which are entirely "biogenic" (the plastics in landfills aren't forming GHGs). The sun's rays do not interview carbon molecules in the atmosphere, ask where they came from, and choose whether to not to heat them up. Carbon in a landfill or in a tree is not the same as carbon in the atmosphere. In debunking the biomass carbon neutrality myth, scientists have pointed out that it relies on a form of double-counting, as international carbon accounting protocols already account for tree and plant growth in their models, and for it to be subtracted or ignoring carbon emitted from biogenic carbon emitting sources is hiding the actual climate impacts.

EPA data shows that emissions of CO₂ from wood burning (biomass incineration) is 50% worse than coal, per unit of energy, and that trash incineration is 150% worse (2.5 as bad). A study commissioned by the Commonwealth of Massachusetts found that for wood burning ("biomass"), it takes 45 years on average for that extra pulse of CO₂ to be reabsorbed by newly growing trees. This is not carbon neutrality, but just getting back down to the level of coal burning. No carbon neutrality can be possible within a meaningful timeframe since we do not have decades to avert the worse global warming tipping points.

Another major flaw is subtracting emissions from coal power plants as if any energy generation at an incinerator displaces coal. In fact, because of trash incineration being considered renewable energy in Maryland, no fossil fuels displacement can honestly be assumed. If trash were not burned, electric suppliers will be required to replace that with other Tier 1 renewable resources with Maryland's Renewable Portfolio Standard – and would most likely be replaced by emission-free wind power. Also, subtracting avoided methane emissions from landfills is a dishonest way to do a comparison between incinerators and landfills. Similarly, one would not do a comparison where the landfills can subtract incinerator emissions, or where coal power plant owners can plant enough trees and pretend that their actual stack emissions are negative.

If one is rightfully concerned about the greenhouse gas impacts in the waste system, then it's imperative that incineration is not used, and that readily degradable organics (food scraps and yard waste) are kept out of landfills.

⁴ Morris, Jeffrey, "Recycle, Bury, or Burn Wood Waste Biomass?: LCA Answer Depends on Carbon Accounting, Emissions Controls, Displaced Fuels, and Impact Costs," *Journal of Industrial Ecology*, August 2016. <https://doi.org/10.1111/jiec.12469>

⁵ <http://www.energyjustice.net/incineration/climate>

⁶ <http://www.energyjustice.net/biomass/climate>

Groundwater

There is no good data to do a comparison of groundwater damage from landfilling unburned trash vs. trash incinerator ash. However, some informed common sense goes a long way. It's not the size of landfills that is harmful, but their toxicity. As described above, incineration creates new toxic chemicals like dioxins/furans, depositing much of them in the ash, and makes existing toxic chemicals more readily available to blow away or leach into groundwater by increasing the surface area.

Ashes and Ash Testing

Two types of ash are produced when trash or other solid fuels are burned: bottom ash and fly ash. Bottom ash, which is what remains on the grate of the boiler, makes up about 90% of the ash. The remainder is "fly ash" – smaller particles that are caught in the air pollution controls. Fly ash is far more toxic and is impregnated with heavy metals and dioxins. Prior to 1994, when incinerator ash was tested with the EP Tox test, the fly ash tested hazardous 94% of the time and the bottom ash tested hazardous 36% of the time. In some other nations, and in two international treaties, incinerator ash is categorically defined as hazardous waste. Until 1994, the U.S. Environmental Protection Agency categorically exempted incinerator ash from hazardous waste regulation. In May 1994, the U.S. Supreme Court ruled that incinerator ash that tests hazardous for toxic heavy metals such as lead and cadmium must be disposed of in hazardous waste landfills rather than in typical municipal solid waste landfills. If incinerators were made to pay for the expense of disposing of their ash as hazardous waste, they'd be out of business overnight. In response to that ruling, EPA saved the industry by changing the test and permitting new practices that consistently avoid a hazardous waste designation. The TCLP test manipulates the pH so that the laboratory test occurs at a pH where lead does not leach out. The use of lime injection in air pollution scrubbers also helps manipulate the pH and EPA allows incinerators to mix the fly and bottom ashes so that the dilution and the injected lime helps the combined ash pass the test. Phosphoric acid can also be used to prevent leaching long enough to pass the test. In real-world, long-term environments, the toxic metals in ash leach out and can be expected to do more damage to groundwater than unburned trash, especially if organics and liquids are kept out of landfills to minimize leachate formation.

What SHOULD we do?

There are three major options for how to manage waste, all of which end in landfilling in some way:

- 1) Landfill directly
- 2) Incinerate and landfill toxic ash
- 3) Zero waste with material recovery and biological treatment prior to stabilized landfilling

Studies comparing landfilling and incineration to zero waste approaches have found – not surprisingly – that avoided production (reduction and reuse), recycling and composting are better for the climate than burning or burying materials,⁷ and that the "leftovers" are best handled with a material recovery and biological treatment (MRBT) process before landfilling.⁸ Material recovery means mechanically removing extra recyclables that are still discarded. Biological treatment means stabilizing any residual organic material with an anaerobic digestion process so that any gas generation is done in an enclosed system where gases can be easily captured, avoiding having a gassy, stinky landfill. Following the Zero Waste Hierarchy provides the best results.⁹

⁷ <http://www.eunomia.co.uk/reports-tools/the-potential-contribution-of-waste-management-to-a-low-carbon-economy/>

⁸ <http://www.ecocycle.org/specialreports/leftovers>

⁹ <http://zwia.org/standards/zero-waste-hierarchy/>