How Waste Incineration Works

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In the U.S., there are two primary methods of garbage disposal — landfilling and incineration. Here is how incineration works in America.

Landfilling is by far the more common of the two, but incineration is the one that generates the most heated (sorry) discussion. Incineration's reputation as a polluting, unsustainable method of disposal is not entirely fair. Under the right circumstances, incineration can be the best choice for a community, but it is not without environmental impacts.

According to the latest EPA data, in the United States, 25.8 percent of municipal solid waste (MSW) is recycled. That number has probably dropped since the data was collected in 2015. Another 8.9 percent was composted. The remaining 65.3 percent was disposed of as garbage, either in a landfill or incinerator. There are 72 incinerators operating in the U.S. They only handle 12.8 percent of the country's garbage, with the rest going to landfills.

Like landfilling, incineration has changed a lot over time. Proponents of the technology don't even call it incineration anymore, but more on that later. Branding aside, the environmental impacts can vary widely depending on the age of the system. The earliest incinerators were just large, inefficient furnaces. They reduced the volume of waste, but large quantities of ash and incompletely burned waste still ended up at the dump.

The 1970 Clean Air Act (CAA) banned the uncontrolled burning of MSW and placed restrictions on particulate emissions. Existing incinerators were required to install new technology or cease operations. However, many of them failed to do so. The CAA was updated in 1977 and again in 1990 primarily to set new deadlines for improving emissions from incinerators.

Facilities built after the CAA, especially after the 1990 update, do meet much higher air quality standards. However, the majority of incinerators in operation today — 55 of them — were built before 1990.

Waste to Energy

The waste management industry usually calls incineration "waste-to-energy," or WTE, to emphasize the energy recovery process that makes modern incinerators both a waste disposal and electric power generating utility.

In most incinerators and all newly constructed ones, the heat released from burning waste is used to produce electricity. This electricity can help to offset the cost of building and maintaining the facility (which is usually significantly more expensive than landfilling). On the EPA's waste management hierarchy, energy recovery is less efficient than recycling and ranks above disposal. Recycling, of plastic at least, saves more energy than combustion generates. But recycling plastic has become its own challenge, and many communities have been forced to treat plastic as nonrecyclable.

Plastics are petroleum products and so have high energy content. That makes them valuable fuel for incinerators. But burning plastics (and other waste materials) generates carbon dioxide, a greenhouse gas that is arguably as dangerous as the toxins that the Clean Air Act regulates. In 2016, more than half of the 12 million tons of carbon dioxide released by incinerators in the U.S. came from plastics.

Incinerators built after 1990 are undeniably cleaner and safer than previous generations of the technology, but many people feel that emitting even trace amounts of toxic substances like dioxins, acids, and heavy metals is neither safe nor acceptable.

Wheelabrator Technologies' Waste-to-Energy plant in Massachusetts, in service 1975. Photo: Fletcher6, CC BY 3.0

The Waste Incineration Process

Every incinerator is unique, but the most common technique is called "mass burn." The general process followed in a mass burn incinerator includes five steps.

1. **Waste preparation:** Oversized items are removed and certain recyclables like metals are recovered. The remaining waste is often shredded before it enters the incinerator.
2. **Combustion:** Waste is burned in an oxygenated single combustion chamber. Materials are burned at extremely high temperatures of 1,800-2,200 degrees Fahrenheit. At those temperatures, waste should be completely combusted, leaving nothing but gases and ash.
3. **Energy recovery:** The gases released during combustion are cooled with water, generating steam through heat recovery. The steam is used to power electrical generators.
4. **Environmental control:** The cooled gas is treated by scrubbers, precipitators, and filters to remove pollutants. The solids that form during

treatment, called residuals, are disposed of in a landfill.
5. **Environmental release:** The treated gas is released to the atmosphere. There should be no visible smoke from the smokestack because the remaining gases should be free from particulates.

Because incineration utilizes such high temperatures, it can destroy many pathogens and some toxic materials. For this reason, incineration is the preferred method of disposal for biomedical and some other special wastes, even in communities where MSW is landfilled.

Environmental Concerns

As many are quick to point out, incineration still has drawbacks. Not all byproducts of combustion are as beneficial as electricity. Fly ash can be recycled as an ingredient in concrete but is also a hazardous material that contains heavy metals and other pollutants.

Incineration can never completely replace landfilling. Waste must be presorted before burning — with oversized and certain hazardous items going to the landfill. But waste also remains after burning. From 15-25 percent (by weight) of the MSW burned remains as bottom ash that goes to the landfill.

Many people fear that incineration conflicts with efforts to reduce waste. While there is a financial incentive to generate as much energy as possible, countries with the highest recycling rates also tend to be the ones that rely on waste-to-energy over landfilling. Even so, incinerators rely on a constant stream of waste to operate efficiently. Countries like Sweden that are good at recycling and depend on WTE for a significant amount of energy have had to resort to importing garbage to keep their incinerators running.

Whether landfilling or incineration for WTE makes more sense for a community depends on the resources and eco-vulnerabilities of the location. Communities that lack suitable space for a landfill or a low-carbon means of transporting waste to a landfill, or communities where WTE is cleaner than their current energy mix, might be best served by incineration.

Ultimately, generating less garbage is the only way to eliminate the environmental impacts of garbage.

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