Center for American Progress

Energy from Waste Can Help Curb Greenhouse Gas Emissions

Matt Kasper April 17, 2013

The United States currently generates 390 million tons of trash per year, or 7 pounds per person per day.[1] Municipal solid waste, or MSW, commonly known as garbage, gets picked up from homes and businesses on a weekly basis and is usually sent straight to a landfill. At the landfill, a hole is dug in the ground and then lined with a man-made liner. As trash begins to fill the hole, methane is emitted as a result of waste being broken down by anaerobic bacteria. Once the landfill is full, it is capped to limit water from seeping into it.

Although many states have the physical space for trash, it is environmentally unsustainable to take garbage and bury it in the ground at landfills, where it decomposes and releases potent greenhouse-gas pollution. What's more, some trash has to be transported by diesel trucks or trains to landfills several hundred miles away, further exacerbating its pollution footprint. Though garbage is not something we tend to actively think about on a daily basis, specifically as it relates to climate change, the United States must begin developing policies to limit the environmental consequences that result from our generation of garbage.

There are already some efforts in place to help manage trash creation. Though America's MSW generation has significantly increased over the past decades as a result of population growth, the country has also seen tremendous improvements in recycling and composting efforts, for example. In 1960 the United States recycled only 5 million tons of garbage, but today America is recycling and composting more than 90 million tons.[2] This increase is largely a result of many state and local governments introducing recycling requirements as well as recycling incentives.

But there is another alternative waste management option that America has not significantly utilized but that could help stem the flow of waste, and thus pollution emissions, in our country: energy-from-waste, or EfW, facilities. These facilities provide a means for waste disposal while also generating clean electricity. EfW plants burn garbage in a controlled environment that generates electricity, which in turn is sold to utilities and then distributed to residential, commercial, and industrial consumers.

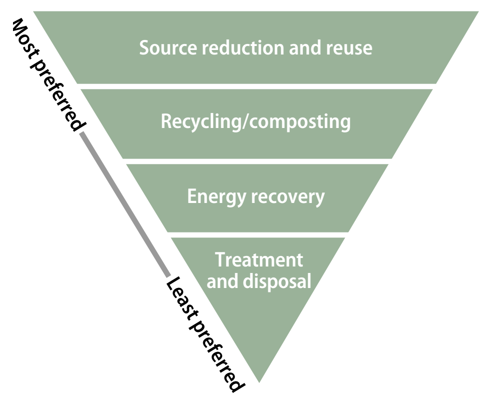
As America's population continues to increase, greenhouse-gas emissions, specifically methane from landfills, will also rise as more garbage is generated. Scientists in Hawaii found just last month that the amount of carbon dioxide in the atmosphere jumped dramatically to a new record high in 2013.[3] America's business-as-usual plan has the nation on the wrong path. Federal legislators need to begin to find more ways to decrease the amount of greenhouse gases in the atmosphere, and a plan that combines increases in EfW usage and recycling and composting would be a good start. This issue brief addresses the need for the United States to increase rates of recycling, composting, and EfW to combat climate change, explains the technology at work in an EfW facility, and makes policy recommendations that will drive down the emissions released by landfills.

Energy from waste reduces greenhouse gas emissions

States can have both EfW and recycling strategies that are compatible. Indeed, communities using EfW technology have an aggregate recycling rate above the national average.[4] Figure 1 illustrates the waste-management hierarchy created by the U.S. Environmental Protection Agency, or EPA, that states and cities have begun to follow.[5] Reducing the amount of trash generated is the most preferred and cost-effective method, followed by recycling and composting practices.

Currently, recycling and composting actions together decrease the United States' 390 million tons of MSW to 296 million tons, but a nationwide waste standard—mandatory levels of waste to be processed at EfW facilities and landfills—that incorporates recycling goals could reduce this number even further.[6] Nevertheless, waste will always be generated, and instead of disposing of it in landfills, America should be sending it to energy-from-waste facilities.

FIGURE 1
Inverted Pyramid of Waste Management



Source: Environmental Protection Agency

According to the EPA, for every ton of garbage processed at an EfW facility, approximately one ton of emitted carbon-dioxide equivalent in the atmosphere is prevented.[7] This is because the trash burned at an EfW facility doesn't generate methane, as it would at a landfill; the metals that would have been sent to the landfill are recycled instead of thrown out; and the electricity generated offsets the greenhouse gases that would otherwise have been generated from coal and natural gas plants.[8]

The European Environmental Agency, or EEA, notes that increasing rates of recycling and EfW will decrease the amount of greenhouse gases a country emits.[9] After the EEA study was released, the European Union adopted proactive waste policies, including the promotion of recycling and EfW as alternative waste-management strategies. In fact, the European waste sector achieved a 34 percent greenhouse-gas-emissions reduction from 1990 to 2007, the largest pollution reduction of any industry in the European Union.[10]

The EPA and EEA are not alone in recognizing the benefits of energy from waste. The Intergovernmental Panel on Climate Change called EfW a "key [greenhouse gas] mitigation measure," and the World Economic Forum included EfW in its list of technologies likely to make a significant contribution to a future low-carbon energy system.[11]

Trapping methane gas isn't as beneficial as EfW

Landfills in the United States are using different kinds of available technology to help decrease the amount of emissions released. One such method is to trap methane and use it as energy: Of the 1,900 landfills in the United States, all of which are covered by the EPA's air emissions and solid-waste-management regulations, approximately 560 are using techniques to capture methane gas and turn it into electricity.[12] These landfills are able to reduce the amount of methane emitted compared to the landfills that do not generate electricity,[13] but even those equipped with methane-recovery systems generate significant emissions for a number of reasons.

First, methane collection does not occur over the duration of the emitting cycle. Landfills are not obligated to collect gas immediately, nor are they required to collect it for the entire period during which methane is being generated by anaerobic decomposition. This often means that only a fraction of the gas that is produced is collected. EPA's Waste Reduction Model, which tracks greenhouse-gas emissions from different waste-management practices, estimated that when garbage in landfills begins to emit methane, only an average of 34 percent is recovered to produce electricity.[14] Another 38 percent of methane emissions in landfills are flared, which is the process of releasing gas and burning it, and the remaining 28 percent of waste experiences no recovery whatsoever.[15] Consequently, landfills are the third-largest contributor of anthropogenic methane emissions in the country, accounting for 16 percent of total methane emissions as a result of human activities in 2011 and preceded only by the natural gas and agricultural sectors, respectively.[16]

Second, the efficiency of gas collection varies over time even when gas-collection systems are active and their average performance falls short of industry claims. A 2012 report prepared by the EPA and ARCADIS U.S., Inc., an international company that provides consulting and engineering services in the fields of infrastructure, water, environment, and buildings, states that:

> *Most of the existing data that is available to evaluate fugitive emissions from landfills is based on flux box data. These measurements do not account for the majority of losses found at landfills and therefore can potentially understate the emissions that escape to the atmosphere. With the increased interest in improving greenhouse gas emission inventories and strategies for emission reductions, there is a need to better quantify landfill gas collection efficiency.*[17]

To better understand emissions from landfills, the researchers undertook source-measurement approaches and concluded that "the methane abatement efficiency [ranged] from 38 to 88 percent."[18] In other words, the landfills studied are only capturing an average of 62 percent of methane emissions, despite the 75 percent default gas-collection efficiency recommended by EPA's guidance for emission inventories.[19]

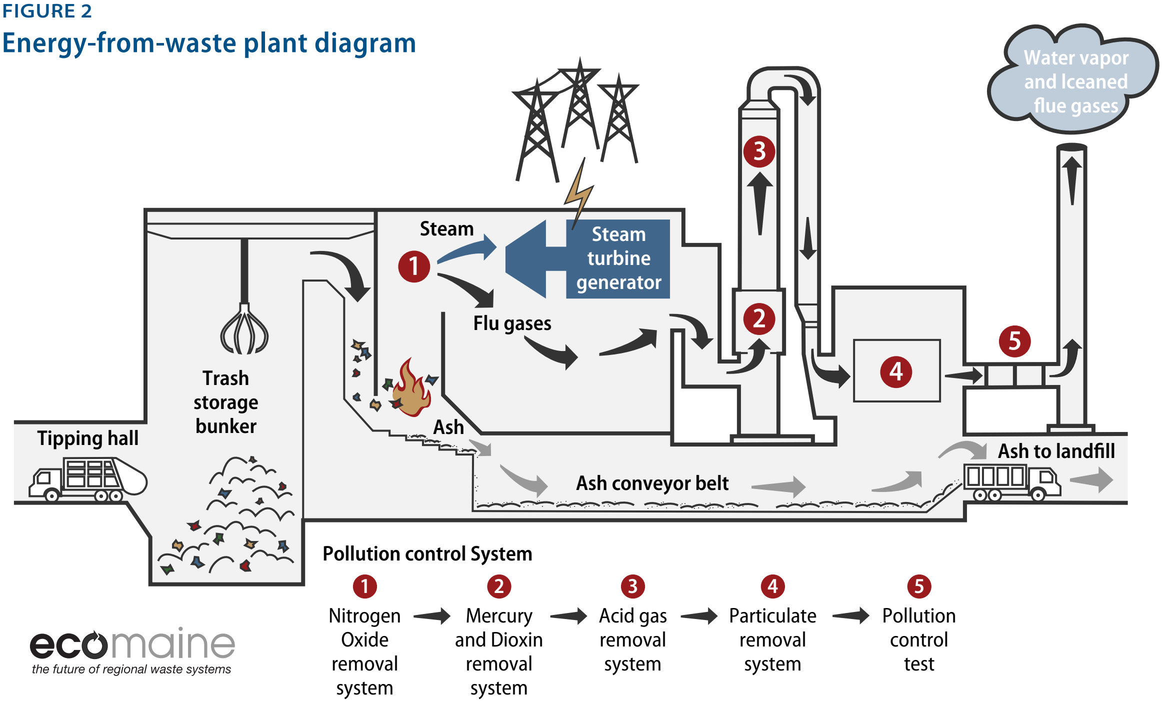
In order to reduce greenhouse-gas emissions, garbage must be diverted from landfills and sent to EfW facilities after significant recycling and composting efforts are accomplished. In fact, EPA scientists concluded that sending waste to EfW facilities is the better option not only for generating electricity, as the technology is capable of producing 10 times more electricity than landfill-gas-to-energy technology, but also because greenhouse-gas emissions from landfills—even those with optimum conditions for capturing methane and turning it into electricity—are two to six times higher than those generated from EfW facilities.[20]

How energy from waste works

Disposing of waste in landfills is the most commonly used management technique in the United States, accounting for 69 percent of total garbage disposal.[21] Some local governments, however, have begun to send their trash to EfW facilities, totaling 7 percent of total waste disposal.[22] Instead of transporting trash to the landfill, garbage trucks deliver the waste to an EfW facility, and in some cases the trash is even loaded onto railcars for delivery, which eliminates both truck traffic and diesel pollution.[23]

FIGURE 2

Energy-from-waste plant diagram



Source: ecomaine

Once the trash has been delivered to the EfW facility, it is dropped into a pit where a grapple will transfer the trash to a combustion chamber. Inside the combustion chamber, the trash is burned, causing water to boil, which will lead to the creation of steam. The steam then spins turbines to generate electricity. Throughout this process, filters are trapping fly ash, particulate matter, and metals from the trash that are not burned and are collected for recycling or even to be used in projects such as road construction and landfill-cover material. Gases from the burned waste are collected, filtered, and cleaned before being emitted. The remaining quantities of residue are collected through the filters, stored, and then sent to landfills for disposal. The electricity generated as a result of the spinning turbines goes to a switchyard and then gets transferred onto the grid for utilization and purchase.

A typical EfW plant is able to generate about 550 kilowatt-hours per ton of waste while complying with all state and federal standards.[24] This process has led many to recognize EfW facilities as a form of renewable-energy technology. In fact, the Energy Policy Act of 2005, which authorized loan guarantees, tax credits, and energy bonds for technologies that avoid greenhouse-gas pollution, included it as a renewable-energy resource.[25]

Under the Clean Air Act, EfW facilities must use the most modern air-pollution-control equipment available to ensure the smokestack emissions—carbon monoxide, nitrogen oxides, soot, and mercury—are safe for human health and the environment.[26] All facilities are specifically subject to regulations under the EPA's Maximum Achievable Control Technology Standards, which created emissions standards for industrial and commercial industries.[27] Because of the high temperatures inside the combustion chambers, most pollutants do not escape through the smokestacks, but scrubbing devices are installed in all EfW facilities as another control system to limit dangerous emissions.

EfW plants do involve large upfront expenditures, which can be a hurdle when building a new facility. A new EfW plant typically requires at least $100 million to finance construction costs, and this could be doubled or tripled depending on the size of the plant.[28] In order to finance the plant, facilities will require municipal revenue bonds, which are issued by local governments or agencies to secure revenue for essential service-infrastructure projects and are repaid with interest. Long-term contracts, however, are often developed between the facility and the county or city government that secure the facility-waste tipping fee, or the price charged for the trash received at a processing facility that is then used to pay back bonds and operating costs. Contracts are also established with utilities to receive income from the electricity generated and sold to the grid. This money is then used to pay back the bonds with interest.

Furthermore, hauling trash to landfills is expensive for large cities in America. New York City, for example, paid more than $300 million last year just to transport trash to out-of-state landfills.[29] In these cases, EfW facilities could be immediately beneficial by saving governments money while generating jobs and local revenue from an EfW facility. In other regions of the United States, however, it can be cheaper to send trash to landfills when looking at a short-term economic analysis due to the amount of land available for trash disposal. Arkansas has an average landfill tipping fee of $35 per ton of garbage and has a reserve capacity of more than 600 years.[30] This is less than the U.S. average tipping fee of $45 per ton and also is below the average tipping fee at an EfW facility of $68 per ton.[31] But on a long-term economic basis, EfW facilities cost less than disposing of waste in landfills due to returns from the electricity sold and even the sale of recovered metals.[32] Indeed, Jeremy K. O'Brien, director of applied research for the solid-waste-management advocacy organization Solid Waste Association of North America, writes that, "Over the life of the [EfW] facility, which is now confidently projected to be in the range of 40 to 50 years, a community can expect to pay significantly less for MSW disposal at a [EfW] facility than at a regional MSW landfill."[33]

National and state recommendations

The most sustainable and cost-effective approach to limiting the amount of trash sent to landfills is avoiding waste generation entirely. Since that is hardly likely to happen at any point in the near future, however, the United States should create strong policies to increase recycling and composting efforts and implement policies to increase the amount of trash sent to EfW facilities.

The United States currently has 86 EfW plants operating in 24 states processing more than 97,000 tons of waste per day.[34] The New England region—Connecticut, Maine, Massachusetts, Maryland, New Hampshire, New Jersey, and New York—alone has 37 operating plants. Connecticut has the highest percentage of its waste going to EfW plants of any state—about 70 percent of its nonrecyclable trash—and nearly 25 percent of its waste is recycled.[35] According to Eileen Berenyi of the research and consulting firm Governmental Advisory Associates, EfW in Connecticut contributes $428 million annually to the state's revenue and has created nearly 1,000 jobs.[36]

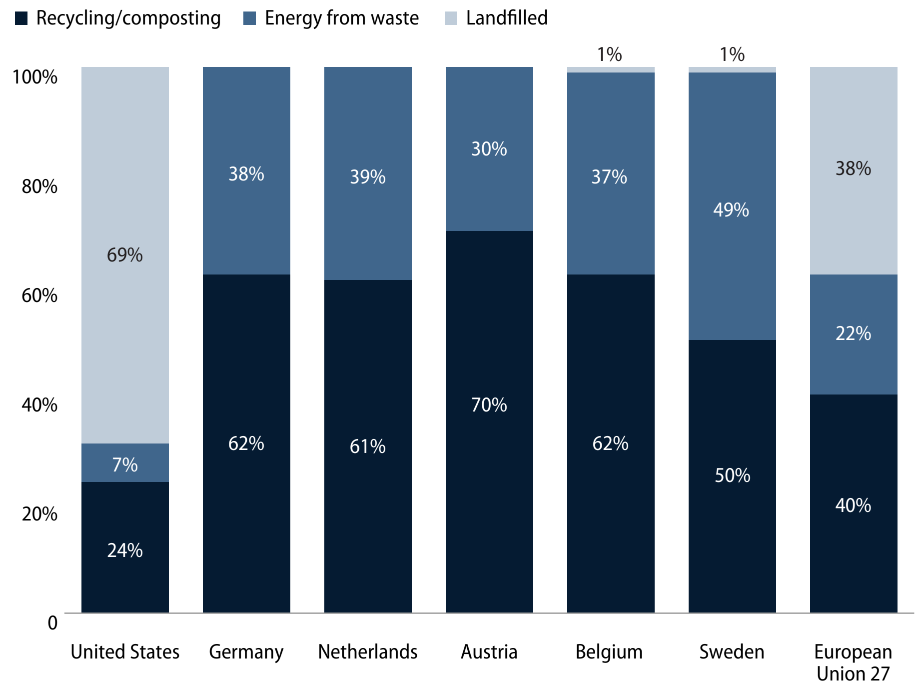
Despite the economic benefits of EfW facilities, the United States as a whole is not taking advantage of EfW technology, especially when compared to Europe. Countries such as Germany, the Netherlands, Austria, Belgium, and Sweden have proved that recycling and EfW management go hand in hand.[37] These five nations have the highest recycling rates in Europe and have reduced their dependence on landfills to 1 percent or below of waste disposal.[38] European nations have been able to achieve these rates because of the EU Landfill Directive,[39] which allows different countries to implement their own programs and policies to drive down the amount of garbage sent to landfills—whether that involves increasing landfill fees or increasing recycling-collection schemes. Nations in Europe also recognize EfW as a renewable energy source and are using this technology to help reach renewable-energy targets.[40]

Because of strong nationwide policies, the EU member states sent 19 percent less trash to landfills in 2011 compared to 2001.[41] This ultimately decreases the amount of greenhouse gases emitted from landfills and helps fight climate change. In order for the United States to begin reducing the amount of waste sent to landfills, increasing recycling rates, and generating renewable energy, a municipal-solid-waste portfolio standard must be enacted by Congress and applied nationwide in order to decrease greenhouse-gas emissions from landfills, and individual states should include EfW in current renewable-energy portfolio standards.

FIGURE 3

European nations are a model for waste management

Management of America's waste compared to European nations



Sources: BioCycle and the Earth Engineering Center of Columbia University; Confederation of European Waste-to-Energy Plants

Municipal-solid-waste portfolio standard

The United States should set a municipal-solid-waste portfolio standard that would not only increase our nation's rates of recycling and composting but would also significantly decrease the amount of garbage destined for landfills. As many European nations have already demonstrated, recycling efforts must be included in any national policy in order to reduce the level of waste in landfills. A few U.S. states have already established MSW strategies; both California and Florida, for example, have enacted a 75 percent recycling, including composting, goal by 2020.[42] Establishing incentives for recycling, such as providing homes and businesses with free recycling containers in conjunction with free pickup for recyclables, and creating a market for recyclable materials is also paramount to achieving those standards. Specifically, an executive order requiring federal government agencies to purchase recycled-content materials will establish a market for these products.

By learning from what some states have successfully implemented, a U.S. nationwide standard should be created that mirrors what the European Union has established. Doing so will protect the environment, conserve energy, and reduce greenhouse gases.

Include EfW generation in state renewable portfolio standards

States' adoption of renewable-energy standards, which require electric-utility companies to produce a portion of their electricity from renewable resources, has considerably driven clean energy advances in recent years. The 29 states and the District of Columbia that have such standards also include landfill gas as an eligible technology, but only 21 states and the District of Columbia recognize EfW as an eligible technology.[43] Maryland has shown the most leadership in this area by raising EfW from a Tier II to a Tier I technology—the same level that solar and wind energy are on—in the renewable portfolio standard, which will increase the percentage of renewable energy from EfW plants allowed in states' portfolio standards.[44] Other states should look to Maryland and Connecticut and adopt similar policies or seek to modify existing waste-management policies so as to reduce incentives for and reliance on landfills and complement their renewable portfolio standard goals.

Importantly, states should modify their renewable programs so they are consistent with the solid-waste hierarchy. While the solid-waste hierarchy identifies landfills as the least-preferred method for managing waste, landfills including ones with methane-gas capture are typically placed on equal or higher standing in renewable programs than EfW. This unintended encouragement of the use of landfills undermines efforts to reduce that reliance, as well as state renewable and greenhouse-gas reduction goals. Such significant financial support for landfills inhibits the growth of solid-waste-management methods such as recycling and EfW further up in the hierarchy.

Conclusion

Both energy from waste and recycling and composting efforts are a win-win-win for the United States. EfW generates clean electricity, decreases greenhouse gases that would have been emitted from landfills and fossil-fuel power plants, and pairs well with increased recycling rates in states. Recycling and composting reduces trash that is destined for the landfill that would have emitted greenhouse gases while decomposing, saves energy that would have been used for the production of a virgin material, and decreases the need to mine for raw materials, which will preserve our natural resources. The United States must begin developing national policies to deal with the waste-management problem our country faces every day. Doing so will ultimately reduce emissions that cause climate change.

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