THE NEW SCHOOL

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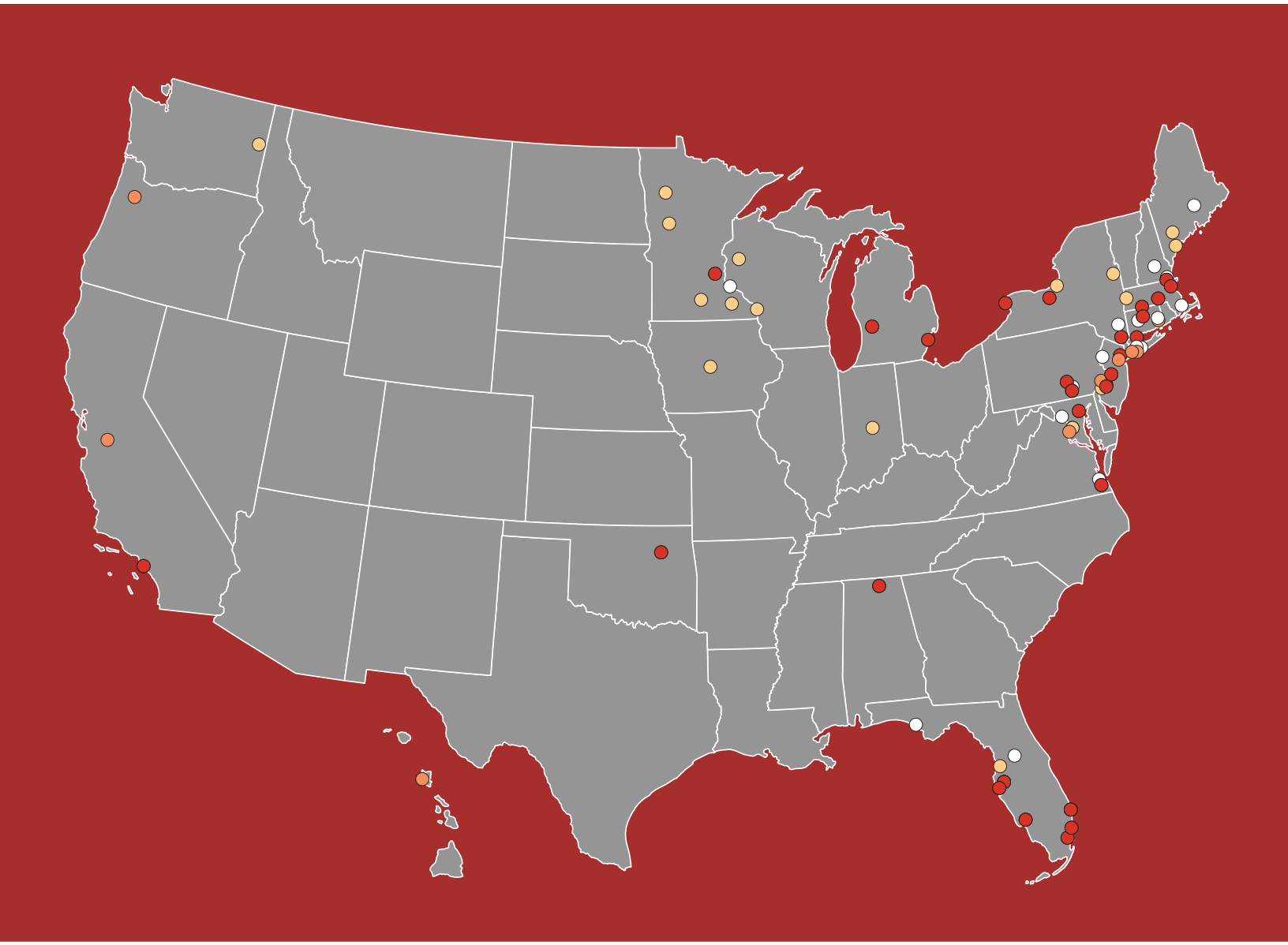

U.S. Municipal Solid Waste Incinerators: An Industry in Decline

May 2019

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About the Tishman Environment and Design Center

The Tishman Environment and Design Center at The New School fosters the integration of bold design, policy, and social justice approaches to environmental issues to advance just and sustainable outcomes in collaboration with communities.
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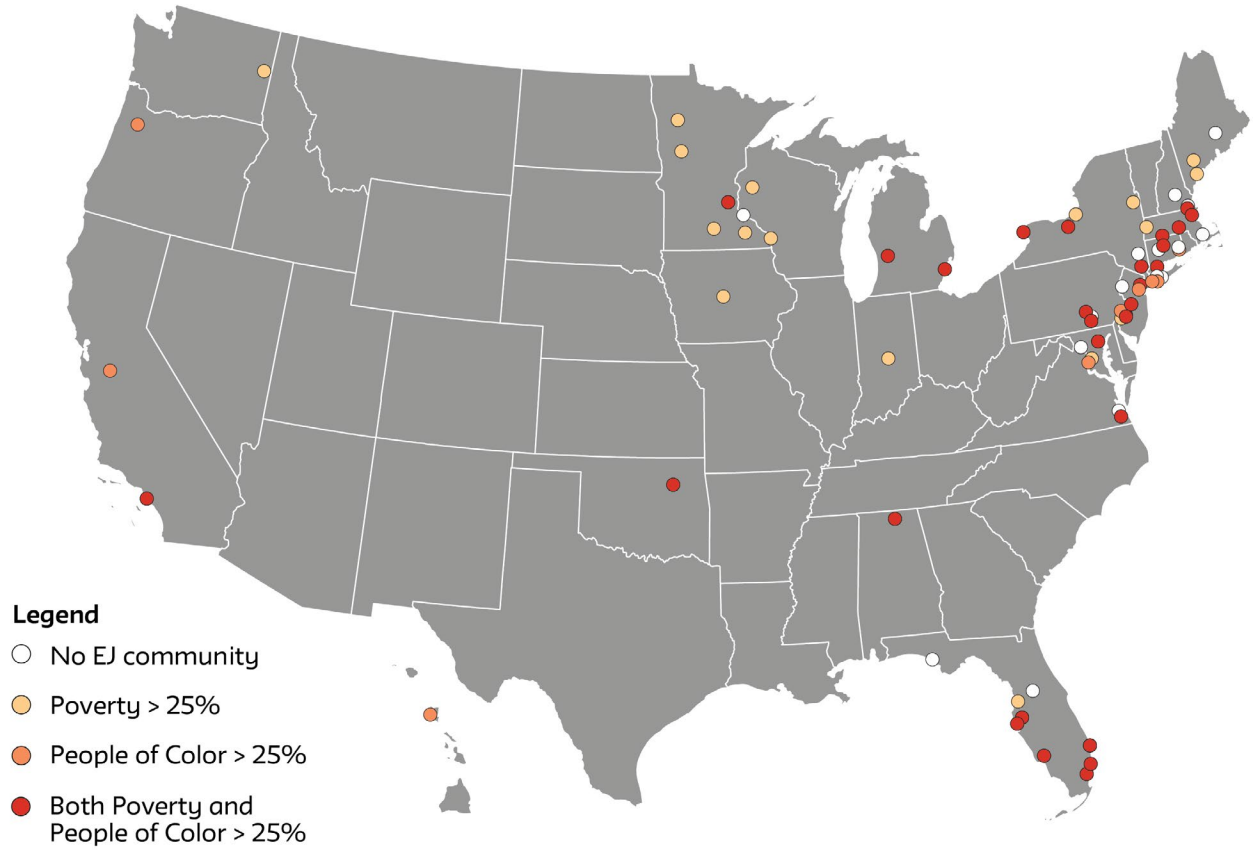
Executive Summary

Municipal Solid Waste (MSW) incinerators have a long history in the United States as a waste disposal system and an equally long history of resistance among communities where they are sited. The current state of MSW incineration seems to be in decline due to a volatile revenue model, aging and costly operation and maintenance costs, and increasing attention to issues of zero waste, environmental justice and climate change. Seventy-three MSW incinerators remain in operation in the U.S., not including those currently designated for closure.[1] The industry saw at least 31 MSW incinerators close since 2000 due to issues such as insufficient revenue or the inability to afford required upgrades.[2]

This report examines three major economic vulnerabilities in the MSW incinerator industry. First, construction and maintenance costs are significant and relatively more capital intensive compared to other forms of waste disposal. Second, the current pool of MSW incinerators have reached or are close to reaching their life-expectancy and now require another round of capital investment, often at the expense and risk of local taxpayers. Third, the industry's revenue streams are volatile, dependent on competitive tipping fees and access to the renewable energy markets. Additionally, the report reveals the relationship between MSW incinerators and environmental justice communities as well as the air pollution and potential health risks related to the incineration industry.

One of the distinct characteristics of garbage incinerators in the United States is that they are often sited in communities of color and low-income communities, also referred to as environmental justice (EJ) communities. **58 incinerators, or 79 percent of all MSW incinerators in the U.S. are located in environmental justice communities.**[3] The incineration industry represents an affront to environmental justice as they contribute to the cumulative and disproportionate pollution placed on communities of color and low-income communities.

MSW Incinerators & Environmental Justice Communities

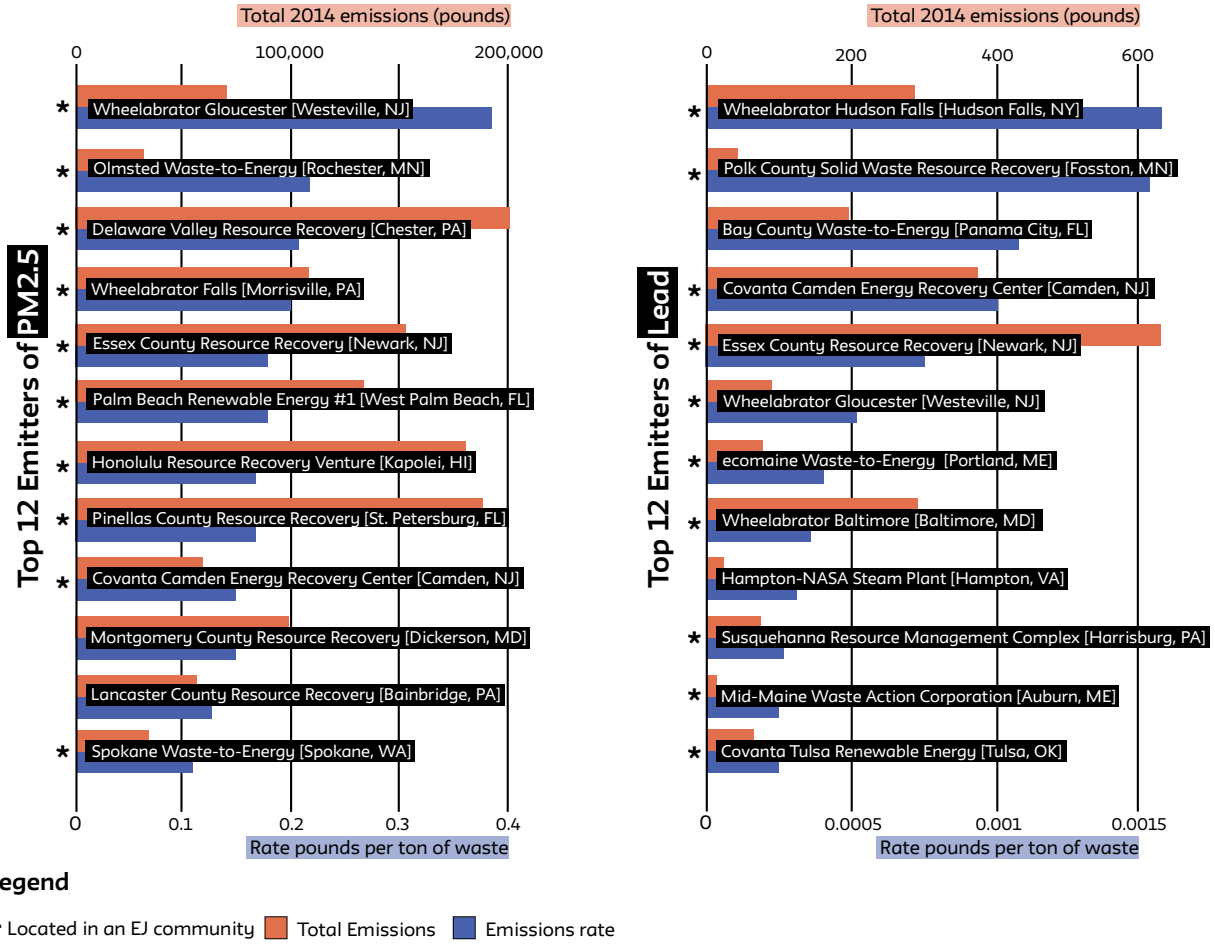


Municipal solid waste incinerators rely primarily on revenue streams from tipping fees and secondarily on energy sales (i.e. steam and electricity). As an example, Covanta Corporation, which controls a large share of MSW incinerators in the country, gets approximately 71 percent of its revenues from tipping fees and 18 percent from electricity sales.[4] These two revenue streams are volatile and can undermine the financial stability of the industry. There is close competition for tipping fees between landfills and incinerators, which means that in places where landfill tipping fees decline or where volumes of waste decrease, an incinerator's primary revenue source can be jeopardized.

Many municipalities are also removing long term "put or pay" clauses from contracts so that they are not required to deliver a set amount of waste to incinerators over time with a threat of financial penalties. Similarly, renewable energy subsidies can change over time, depending on the regulatory and political environment in each state. This leads to an underlying business model at risk, "*As our historic energy contracts have expired and our service fee contracts have transitioned to tip fee contracts, our exposure to market energy prices has increased.*" (Covanta Annual Report, 2018)[5] Another factor that contributes to this industry's potential decline is the average age of incinerators in the U.S., which is 31 years.[6] The life expectancy of an incinerator is 30 years[7] and upgrading decades-old facilities requires another large capital investment, often paid for or subsidized by local taxpayers. Municipalities that finance these upgrades or that are required to deliver large volumes of waste often end up burdening taxpayers, sometimes with ruinous outcomes. Cities like Baltimore, Maryland;[8] Harrisburg, Pennsylvania;[9] and Detroit, Michigan,[10] all faced debt payments to and lawsuits from the incinerator industry that threatened their cities' fiscal stability.

The increasing fixed costs of maintaining and operating incinerators together with competition for tipping fees can mean that the industry relies on energy sales to stay profitable. But burning trash is one of the most expensive forms of energy generation in the U.S., costing $8.33/MWh compared to $4.25/MWh for pulverized coal and $2.04/MWh for nuclear, the second and third most expensive forms of energy generation.[11] Despite these costs and the fact that MSW incinerators produced a negligible 0.4 percent of total U.S. electricity generation (2015), two-thirds of all the incinerators in the U.S. today have access to renewable energy subsidies.[12] These energy subsidies are coming under increased scrutiny as environmental advocates question the classification of waste burning, particularly non-biogenic waste, as renewable energy. The introduction of new carbon pricing policies in states like New York may mean that incinerators, which emit significant amounts of CO2, will face new financial challenges.

One of the primary reasons that communities oppose new and existing incinerators is their contribution to air pollution and related health risks. MSW incinerators are relatively large emitters of air pollutants with some studies showing that they emit several pollutants at a rate exceeding that of fossil fuel power plants.[13] Incinerators also have associated diesel sanitation trucks that deliver waste and emit air pollution in host communities. Stack emissions from incinerators include a variety of pollutants harmful to health such as particulate matter, dioxins, lead, and mercury. Globally, waste disposal, primarily from incineration, contributes to ~8 percent of the total anthropogenic mercury emissions.[14] The Dirty Dozen lists illustrate the incinerators, among the 73 in the country, that emit the largest amounts of air pollutants for PM2.5, NOx, Lead, and Mercury. Approximately 1.6 million people live within a three-mile radius of these facilities (See Appendix E).[15] There are 4.4 million people that live within a three mile radius of all 73 incinerators in the U.S. **Ten of the twelve incinerators that emit the greatest total amount of lead emissions (annually), are in environmental justice communities.** Three of the incinerators that emit the largest total amounts of lead (annually) of all the incinerators in the U.S. are located in Baltimore, Maryland, and in Camden and Newark, New Jersey.



The incinerator industry is in trouble. These aging facilities are too expensive to maintain, too risky to finance, and too costly to upgrade. Incinerators in the U.S. operate under volatile economic and regulatory conditions that threaten their major sources of revenue, tipping fees and energy sales. The current state of the U.S. incineration industry and its economic and environmental impacts serves as a warning to regions around the world considering incineration as an approach to solid waste. These facilities can create financial burdens while generating health-harming air pollution for local communities. Finally, these plants represent an environmental injustice because they burden communities of color and low-income communities where they are located. Incinerators are coming under increasing pressure in the United States and around the world to be replaced with more just and sustainable alternatives to waste management.

Chapter 1: HISTORY OF THE INCINERATION INDUSTRY

Municipal solid waste (MSW) incinerators have a long and troubled history as a waste management strategy dating back more than a century in the United States. These facilities have taken many forms over the years and have faced an equally long history of resistance among communities where they are sited. While the trajectory of the industry has waxed and waned in the last 50 years, the current state of MSW incineration seems to be in decline.

There are currently 73 MSW incinerators, not including those currently designated for closure.[16] Collectively, these 73 incinerators burn about 13 percent of all MSW produced in the United States and have an annual revenue estimated to be $3.2 billion.[17] Despite these profits, the industry saw at least 31 MSW incinerators close since 2000.[18] Closures are largely due to insufficient revenue and inability to afford required upgrades.

Most incinerators were built in the 1980s and have exceeded their life expectancy of 30 years.[19] The age of these facilities is a prime contributor to the industry's overall decline and a factor in the various equipment issues and shutdowns that have taken place over the last decade. The industry has also sought to generate additional revenue streams through federal and state classification as a "renewable energy source," hence the shift in branding incinerators from "refuse facilities" to "waste to energy" (WTE) plants.

Table 1: Age of MSW Incinerators

Year of Construction	Number of Facilities
1970-1979	3
1980-1989	45
1990-1999	24
2000s	1

While garbage incineration as "waste-to-energy" has been sold to governments and the public as a technologically-advanced approach to handling solid waste, with the bonus of producing energy, relatively little energy is actually derived from these plants.[20] Combined, these facilities produced approximately 0.4 percent of total electricity generation in the U.S. in 2015.[21] In fact, MSW incinerators are expensive to operate and produce criteria air pollutants like particulate matter as well as relatively more greenhouse gas emissions than coal-fired power plants.[22] Approximately 25 percent of the trash incinerated at MSW plants also remains as toxic ash requiring landfill disposal.[23] Emissions from incinerators include hazardous air pollutants like mercury, lead, and dioxins.[24] The air pollution and associated public health impacts will be further explored in Chapter 3 of the report and implications around energy production will be discussed in Chapter 2.

The history of garbage incineration in the U.S. dates back more than a century. The first garbage incinerator was introduced in the U.S. in 1885 to dispose of waste from an army post on Governor's Island in New York.[25] That same year, the first municipal solid waste incinerator was built in Allegheny, Pennsylvania.[26] From 1885 to 1908, an estimated 180 waste incinerators were constructed across the United States.[27] These early incinerators were mass burn plants using specialty furnaces developed by European manufacturers.[28] In densely populated areas like New York City, incinerators were popular due to the lack of cheap land nearby to develop and expand large landfills. But the cost of building and operating an incinerator was also expensive relative to landfills.[29] It has been estimated that by the late 1930s, the United States had more than 700 garbage incinerators.[30] In the 1960s, New York City had 22 municipal incinerators and thousands of incinerators in apartment buildings, burning nearly one-third of all of the city's trash.[31] While use of incinerators continued to grow in the first half of the 20th century, landfilling remained a relatively cheaper and more commonly used option throughout the country.[32]

Consumption, Waste Management and the Growth of the Incineration Industry: 1970s – 2000s

> *"The U.S. produces more than 30 percent of the planet's total waste, though it is home to only 4 percent of the world's population."*[33]

During the second half of the 20th century, numerous factors impacted how municipal solid waste was produced, managed and disposed.[34] One of the most significant factors driving this was Americans' growing appetite for consumption fueled in part by increased marketing to stimulate consumer habits after World War II.[35] This increased consumption also produced immense amounts of waste. There is a correlation between increased wealth and waste generation. Richer countries are far likelier to produce more waste per capita than poorer countries.[36]

Production of garbage rose steadily since the 1960s. The growth in consumption and production of plastics was particularly harmful to public health. Figure 1 shows total MSW generation and per-capita generation over the past 60 years. In 1960, Americans produced 2.68 lbs/person/day of waste, a total of 88 million tons. [37] By 2015, that increased to 4.48 lbs/person/day and a total of 262.4 million tons of

waste.[38] The amount of plastics in the waste stream in 1960 was negligible.[39] But by 2015, plastics made up about 13.1 percent,[40] or 34.5 million tons of the waste stream.[41] As Figure 1 illustrates, total MSW generation grew 199 percent from 1960 to 2015.

Prior to the introduction of plastics, American waste was primarily composed of organic or biogenic materials. The introduction of plastics in the consumer marketplace in the 20th century, while heralded as an important innovation also introduced new public health and environmental concerns. The properties, which popularized plastics, its versatile and durable qualities, also made disposal difficult.[42] Most plastic products produced since the 1950s have not been recycled but have been landfilled, incinerated, or remain as pollution in oceans and waterways.[43] In fact, the U.S. only recycles 9.1 percent of plastic waste, less than the 15.5 percent that is incinerated and some studies estimate plastics recycling as low as 2%[44] after accounting for plastics exportation that is counted as recycled.[45]

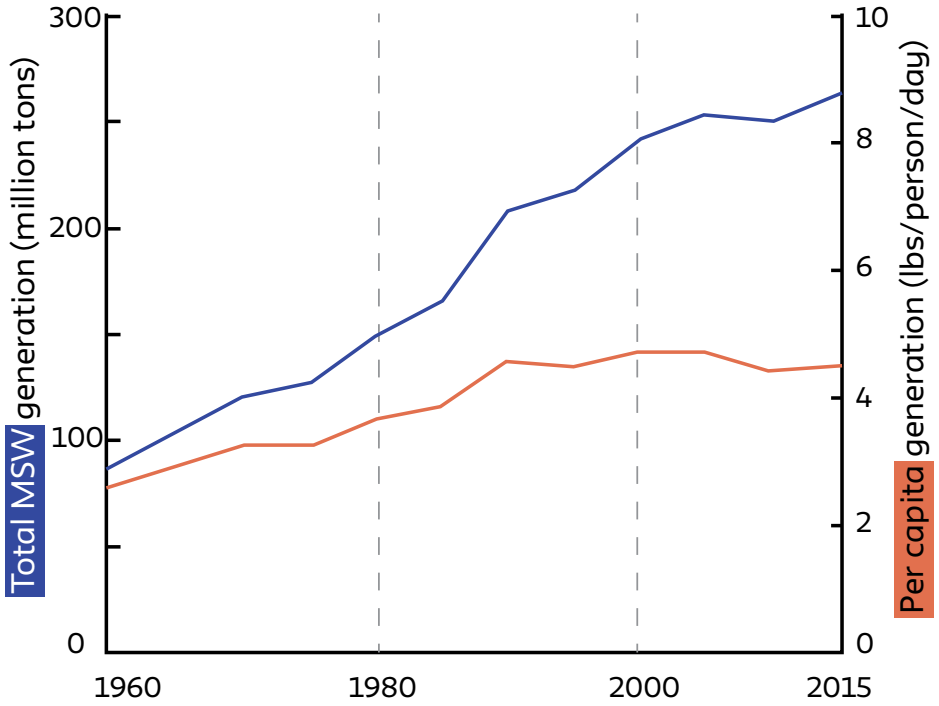
Studies have shown that recycling plastic saves more energy than combustion.[46] Unfortunately, the recent boom in hydraulic fracturing has aided the growth of the plastics industry as a surge of natural gas supplies makes plastic production cheaper.[47] Figure 3 shows the type of waste generated in the U.S. in 2015 by material. Much of this waste, about 90 percent, could be reused, recycled, or composted instead of landfilled or burned.[48] As shown in Figure 2, the U.S. landfills 52 percent of the MSW generated; incinerates ("Combustion with Energy Recovery" in the Figure) 13 percent of MSW; recycles 26 percent; and composts 9 percent.

The growth in household waste and the increasing composition of non-biogenic waste directly impacts incinerator emissions. As MSW incinerators burn more materials containing toxic chemicals, the subsequent emissions will also include more hazardous air pollution. In vulnerable communities, where the U.S. incineration industry is mostly located, burning waste products with toxic compounds impacts the health and well-being of people in these overburdened areas. Ironically, these low-wealth areas that host incinerators tend to contribute the least to the problem because these households consume less on average than wealthier households.[49]

Federal Oversight of the Incineration Industry

Federal oversight and regulation of the incineration industry has evolved over time through diverse air, energy, and solid waste related policies. Figure 5 details this history of federal laws, legal decisions and regulations pertaining to the incineration industry.

Figure 1: MSW generation rates: 1960 - 2015



Source: U.S. EPA, Advancing Sustainable Materials

Figure 2: U.S. MSW Waste Disposal Methods (2015)

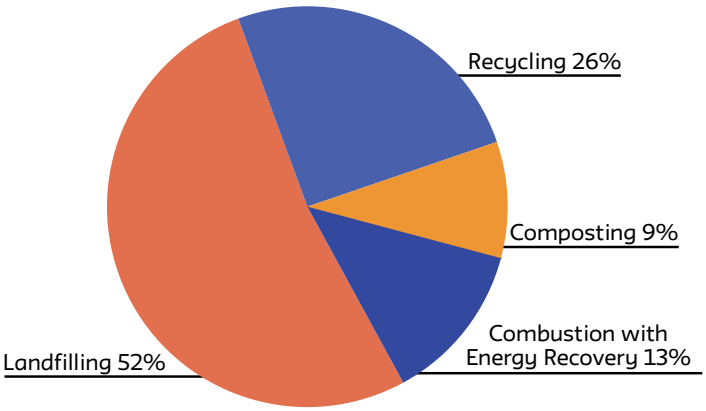
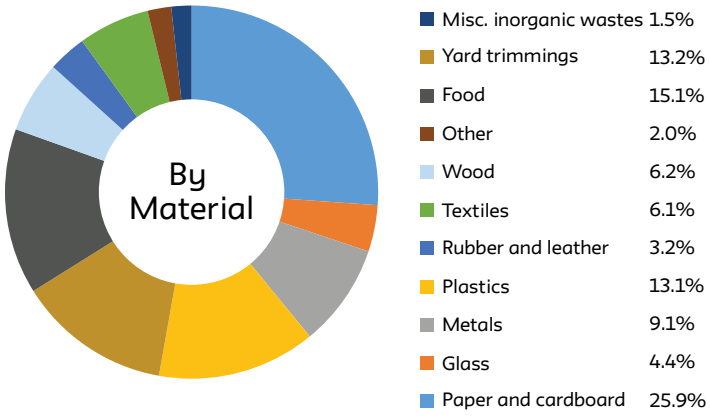


Figure 3: U.S. MSW Waste By Material (2015)



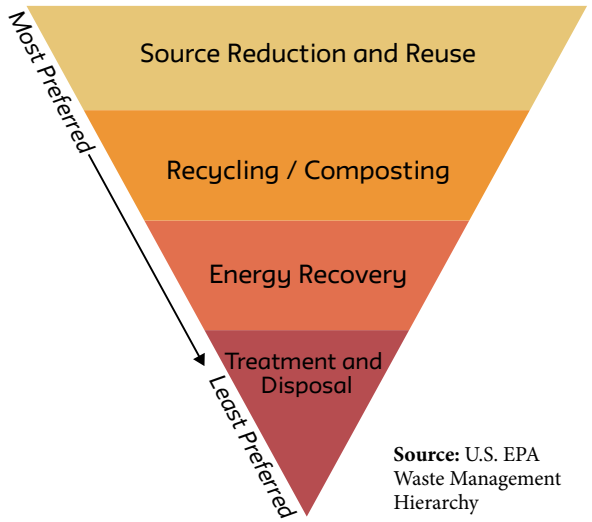
Source: U.S. EPA National Overview Facts and Figures on Materials, Waste and Recycling 2015.

In 1970, the **United States Environmental Protection Agency (U.S. EPA)** was established as a new federal agency and the federal **Clean Air Act (CAA)** was enacted. Under the CAA, the EPA banned uncontrolled burning of MSW and placed restrictions on particulate matter.[50] The law led to the closure of many of the older incinerators because they lacked required emissions controls, which were expensive to retrofit. The share of municipal solid waste being processed by incinerators declined from 31 percent in 1960 (these were primarily incinerators without energy recovery) to 9 percent in 1980.[51] Between World War II and 1979, the number of incinerators plummeted from 300 to 67.[52]

In the early 1970s, as the U.S. EPA expanded research and guidance on waste management in the United States, it became clear that the Solid Waste Disposal Act of 1965 was not sufficient to protect human and environmental health.[53] In 1976, the federal government enacted the **Resource Conservation and Recovery Act (RCRA)** that is still the defining law regulating solid waste today.[54] RCRA gave the EPA authority to regulate and create policies for managing solid and hazardous waste. Landfills became more tightly regulated.[55] Many open dumps shut down across the country.[56] Between 1980 and 1986, the number of landfills went from 20,000 to 6,000.[57] These regulations made landfill maintenance more expensive and over time, helped consolidate waste management into a smaller handful of larger, well-financed private sector companies that could keep pace with costs.[58] Since the enactment of RCRA, state environmental agencies and county authorities were charged with implementing solid waste management laws and issuing solid waste permits.[59]

The U.S. EPA also created a Waste Management Hierarchy (Figure 4), which prioritized source reduction and reuse first, recycling and composting, and then incineration (energy recovery) and landfilling last. Many recyclable, compostable and largely biogenic materials are being burned in MSW incinerators instead of composted, recycled, reused or reduced as recommended by the U.S. EPA's Waste Management Hierarchy. One of the central critiques of relying on large incineration facilities is that they require high volumes and constant flows of waste to remain profitable. This need for running the facilities at their maximum capacity undermines more sustainable and preferable methods of preventing or diverting waste from burning or landfilling.

Figure 4: U.S. EPA Waste Management Hierarchy



Source: U.S. EPA Waste Management Hierarchy

Figure 5: Time line of Incinerator Industry Laws & Regulations

Other regulations and policies enacted in this time period impacted MSW incineration. The **Public Utility Regulatory Policies Act** (1978) allowed investor-owned utilities to purchase electricity from independent producers, including MSW incinerators, through power purchase agreements, up to a limit of 80 MW of electricity.[60] This gave incinerators another source of revenue. In 1988, the federal government stopped the dumping of industrial, medical, and sewage waste into the ocean through the **Ocean Dumping Ban Act.** This narrowed the list of MSW disposal methods. In 1990, as part of new amendments to the Clean Air Act, officials implemented the **Maximum Achievable Control Technology standards (MACTs)** that limited pollution from MSW combustion plants.[61] These standards forced plants to achieve a similar level of emission control "already attained by an average of the best performing, top 12 percent, sources in each pollutant category."[62] While MACTs helped reduce criteria and hazardous air pollutants emitted from MSW combustion, there are still significant emissions that pose a risk to human and environmental health.[63]

In the 1980's the MSW incinerator industry saw a resurgence in new facilities. The closure of thousands of landfills was due to the introduction of RCRA rules, the energy crisis in the 1970's, and the industry's efforts to rebrand itself as an energy source. As shown in Figure 6, the proportion of MSW being combusted with energy recovery systems grew during the 1980s and 1990s along with the shift to branding incinerators as 'waste-to-energy' plants.

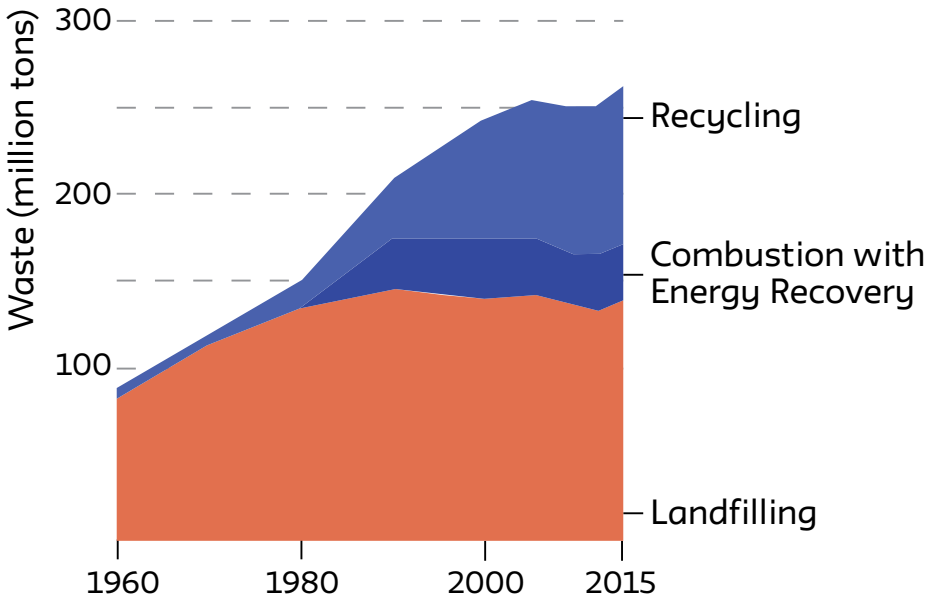
In the late 1990s, cities largely stopped building MSW incinerators. Communities targeted for hosting incinerators fiercely opposed the siting and municipalities were increasingly wary of the large capital costs to build and maintain these facilities. Dioxins and mercury research in the early 1990s helped to inform the opposition to the incineration industry as public concern grew over the link between cancer and dioxins.[64] In the 1990s, incinerators were found to contribute to the growth of mercury pollution in the atmosphere, while at the same time, the U.S. began to ban products with mercury due to health risks.[65]

Privatization and Deregulation of Waste

During the 1980s and 1990s, multinational corporations were able to consolidate their control of the municipal solid waste system as a valuable commodity.[66] As new regulations required more capital and technological capacity to manage larger quantities of waste, the industry began to regionalize in order to achieve economies of scale. Private corporations began to enter this market to create regional systems for waste transfer, processing and disposal.[67] By 2000, four waste management corporations across the entire waste disposal sector (including Waste Management and Allied Waste) controlled 85 percent of the total waste industry revenues.[68]

Three key court decisions also significantly impacted the business model for MSW incineration. The deci-

Figure 6: Municipal Solid Waste Management: 1960-2015



Source: U.S. EPA National Overview: Facts and Figures on Materials, Wastes and Recycling

sions in C&A Carbone Inc. v. Town of Clarkstown, and Oregon Waste Systems, Inc. v. Department of Environmental Quality of the State of Oregon, defined waste and disposal capacity as commodities and limited governments' ability to control the movement of waste within their jurisdictions.[69] In 1994, in the C&A Carbone, Inc. v. Town of Clarkstown decision, the court found that "flow control ordinances" violated the Interstate Commerce Clause.[70] The town of Clarkstown signed a contract with a waste processing plant promising at least 120,000 tons of waste per year. In order to meet their contract, the town passed a flow control ordinance mandating all city waste be processed at this designated plant. This provided a guaranteed revenue stream to the waste processing company.[71] Such contracts, called "flow control ordinances" were commonplace, and many incinerators entered into these contracts with municipal governments. In the Carbone case, the Supreme Court found these mandates or "flow control" ordinances unconstitutional and defined waste as a commodity that should not be restricted for the benefit of some competitors.[72] After this decision, two city-owned incinerators in Ohio, unsure of their ability to meet financial obligations absent the flow control ordinances, were closed.[73]

The second decision, Oregon Waste Systems, Inc v. Department of Environmental Quality of the State of Oregon, found that surcharges on out-of-state trash being disposed of at in-state facilities, violated the Inter-state Commerce Clause.[74] The State of Oregon argued that the surcharge was fairly used so as to make out-of-state waste producers pay the same amount for waste disposal as in-state producers.[75] But by striking down these surcharges, incinerators benefited because they could receive out-of-state trash without additional fees that would make their facilities less competitive in the waste disposal marketplace and they could better ensure enough waste flow to their facilities to be profitable.

In 2007, the Supreme Court returned to the question of flow control ordinances in United Haulers Association v. Oneida-Herkimer Solid Waste Management Authority. Waste haulers and a trade association sued the Oneida-Herkimer Solid Waste Management Authority over a flow control ordinance requiring them to deliver trash to the city-owned facility.[76] The flow control ordinance directed waste haulers from Oneida and Herkimer counties to dispose exclusively at facilities under the agency's control. In a 6-3 decision, the Supreme Court ruled in favor of the Oneida flow control ordinance. The Carbone decision previously ruled that flow control ordinances were unconstitutional; however, this Oneida decision found such ordinances constitutional as long as the waste disposal facility was owned by a public agency.[77] In Carbone, the case centered on flow control that benefited privately-owned disposal facilities. The Oneida case made a distinction in the use of flow control based on the rationale that public agencies have different objectives from privately controlled facilities, one serves a public purpose and the other threatens competition among private entities.[78]

Incineration and Environmental Justice Communities

The association of communities of color and low-income communities with waste dumps has a long history of resistance in the environmental justice movement.[79] Since publication of the seminal study, "Toxic Waste and Race in the United States," in 1987, studies have continued to show that race is the most significant predictor of living near a toxic facility along with income.[80] In 1984, the Cerrell Report, commissioned by the California Waste Management Board, stated that "*All socioeconomic groupings tend to resent the nearby siting of major facilities, but middle and upper socioeconomic strata possess better resources to effectuate their opposition.*"[81] The results of this report confirmed the suspicions of environmental justice communities that charged the waste industry of targeting low-income and communities of color for facility siting. "The Cerrell Report fit us to a T', says Mary Lou Mares, one of the leaders of El Pueblo."[82] One of the distinct characteristics of garbage incinerators in the United States is that they are often sited in communities of color and low-income communities, also known as environmental justice (EJ) communities. The stigma and pollution burdens from the association of waste with EJ communities has become a central point of organizing opposition to incinerators.[83]

The siting of incinerators and other polluting facilities in environmental justice communities is not a coincidence but rather it is a product of historic residential, racial segregation and expulsive zoning laws[84] that allowed whiter, wealthier communities to exclude industrial uses and people of color from their boundaries.[85] While suburbs zoned primarily for single family, residential developments, cities

retained and hardened industrial zoning - effectively depressing land values in areas where people of color and low-income people were pushed to reside.[86] Over time, the effect of structural and institutional racism in the U.S. that relegated people of color to marginal lands, close to industry and pollution, continues to be seen today in the patterns of disproportionate siting of incinerators.

There are many reasons why the co-location of communities of color and low-income communities and incinerators is worrisome. These communities face underlying social vulnerabilities due to their socio-demographic status and they are often, already overburdened with disproportionate amounts of pollution from a multitude of sources. Incinerators pose potential health risks for any host community, but these risks are particularly pernicious when one considers the fact that a majority of plants are located in environmental justice communities that are contributing the least to the waste problem and yet are asked to bear the brunt of the larger society's consumptive, throw away lifestyles.[87] Furthermore, the racialized nature of land use patterns means that incinerators are exacerbating environmental racism. This makes incinerators particularly problematic in the U.S. context. In addition to incinerators' implication in perpetuating environmental racism there are a variety of reasons why incineration is considered a "false solution" on the part of environmental justice and environmental advocates across the country. These groups cite the following concerns with incinerators:

- Health impacts from air pollution associated with stack emissions and diesel trucks transporting waste. Exacerbation of underlying health problems such as childhood asthma & cardiac disease.
- Public debt related to financing the construction & maintenance of the incinerator can drain local taxpayers.
- The creation of waste processing hot spots. One facility is located in the area, it can create a precedent for concentrating other waste-related facilities nearby due to depressed land values.
- The stigma of being a dumping ground for waste from wealthier, often whiter communities.
- Decrease in recycling, composting, and waste reduction due to perverse incentives to burn more waste.
- Decrease in property values and commercial businesses because of stigma and nuisance issues.
- Exacerbation of cumulative impacts from multiple sources of pollution.

One of the critical reasons why incinerators are particularly problematic in environmental justice communities is because of their contribution to the cumulative impacts of pollution in these areas. The effect of multiple pollutants from many sources and their interaction with underlying socio-demographic vulnerabilities in overburdened communities' results in what is often termed "cumulative impacts." "Cumulative impacts" is a framework for thinking about and assessing the vulnerability of communities considering both environmental and socio-demographic factors. The California Environmental Protection Agency (CALEPA) defines the term as:

> *Cumulative impacts means exposures, public health or environmental effects from the combined emissions and discharges, in a geographic area, including environmental pollution from all sources, whether single or multi-media, routinely, accidentally, or otherwise released. Impacts will take into account sensitive populations and socio-economic factors, where applicable, and to the extent data are available.*[88]

Though the federal government does not have an official designation for "environmental justice" communities, a number of states and municipalities have working definitions based on race and income thresholds. These thresholds range from relative measures compared to state averages or absolute percentages of racial and income categories within census tracts or block groups. Based on a review of these existing definitions and national averages,[89] the threshold chosen for this national study falls within the range of percentage thresholds used by other states or policies (i.e. Massachusetts, New York).[90] In order to examine the co-location of MSW incinerators and environmental justice communities, the percent of people who identify as "minority" (according the U.S. census definitions[91]) and the percent of people that are below the federal poverty level in the census tracts within a three-mile radius of the plants was compiled from the U.S. EPA's Enforcement and Compliance History Online (ECHO) database.

The definition selected is based on census tracts where: (a) the percentage of people living below the federal poverty rate is above 25 percent OR (b) the percentage of people identify as "minority" is above 25 percent. Some communities met both income and race thresholds. Most existing environmental justice definitions use either the race or income thresholds, but few require both conditions to determine if an area can be deemed an EJ community.[92] Figure 7 depicts the 73 MSW incinerators currently in operation in the U.S. and identifies the facilities located in environmental justice communities according to this definition. The figure shows:

- **58 incinerators, or 79 percent, are located in environmental justice communities.**[93]
- **31** incinerators, or **40 percent**, are in communities where both the thresholds for poverty AND the percentage of people of color is above 25 percent.
- **48** incinerators are in communities where more than **25 percent** of the population is below the federal poverty level (national poverty rate of 12 percent)[94]
- **44** incinerators are in communities where the population is at least **25 percent people of color.**

Source: Kim Hunter. Will Copeland speaking at Breathe Free Detroit Press Conference, May 18 2018.

Detroit Incinerator Closes Down

Renamed the Detroit Renewable Power (DRP) facility in the 1990s, this incinerator reflects many of the industry trends across the market with respect to its declining performance, fiscal troubles and its failed efforts to rebrand itself as an energy facility. The scale of the fiscal burden that the facility imposed on local tax payers was immense – beginning with a $478 million construction bond in the 1980s and then an additional $179 million bond in the 1990s. Ultimately Detroit paid out over $1 billion to operate a facility that polluted the community. The facility was the source of sustained and intense community-led opposition from the time it was proposed until the present day. Groups such as Breathe Free Detroit and Zero Waste Detroit rallied residents to oppose the public financing and public health burdens that the facility imposed on surrounding EJ communities. These groups cited the persistent odor and air pollution violations that emanated from the plant as the drivers for the push to permanently close the facility.

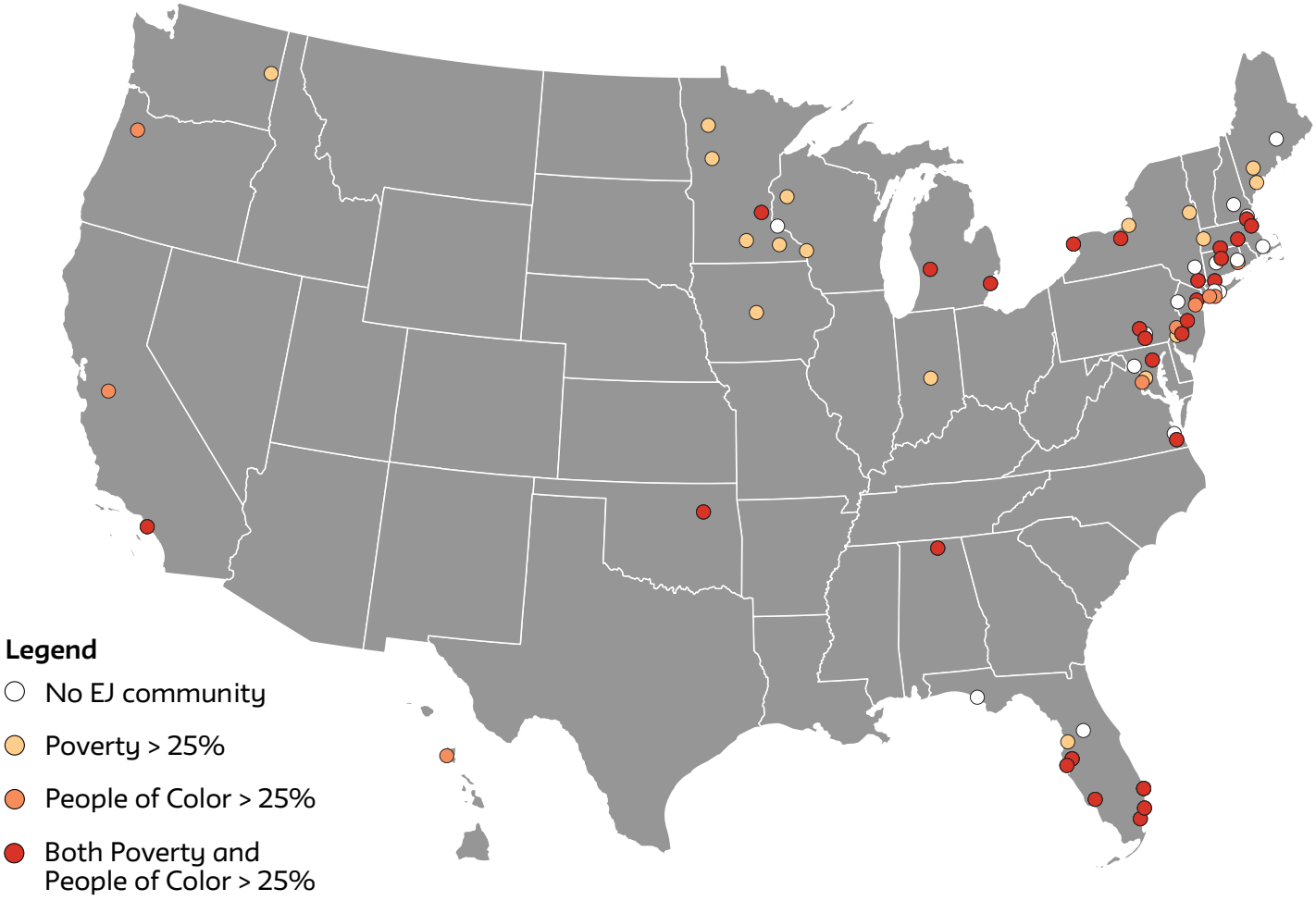
In January 2019, the Great Lakes Environmental Law Center (on behalf of Ecology Center and Environment Michigan) issued a 60-day Notice of Intent to Sue the Detroit Renewable Power Incinerator for violating the Clean Air Act over 600 times in the past 5 years. The threat of this citizen suit, which would likely have required DRP to invest tens of millions of dollars to come into compliance, was a critical factor in the incinerator's closure, which was announced just days before the groups would have actually filed the lawsuit in Federal court. Local organizers celebrated the closure of the Detroit incinerator as a community victory that illustrates the power of long- term, grassroots environmental justice organizing. "We celebrate the closure of one of the world's largest incinerators, a facility that has been a bad neighbor for over 30 years, unable to comply with Clean Air laws and odor restrictions." (Breathe Free Detroit!)

It is important to note that several of the largest and relatively most polluting incinerators (*incinerators reporting high total annual emissions for NOx, PM, Lead, or Mercury relative to all 73 MSW incinerators, please see Appendix E for more detail*) in the U.S. are in census tracts, within 3 miles, that are predominantly low-income or people of color communities. These communities include:

- Honolulu Resource Recovery Venture (Kapolei, Hawaii) has census tracts within a 3-mile radius with a population that is 81 percent minority and 13 percent below the federal poverty rate
- Essex County Resource Recovery (Newark, New Jersey) has census tracts within a 3-mile radius with a population that is 71 percent minority and 37 percent below the poverty rate
- Palm Beach Renewable Energy Facility #1 (West Palm Beach, Florida) has census tracts within a 3-mile radius with a population that is 56 percent minority and 34 percent below the federal poverty rate
- Wheelabrator Baltimore (Baltimore, Maryland) has census tracts within a 3-mile radius with a population that is 66 percent minority and 50 percent below the federal poverty rate

For more detailed information on where incinerators are located in relation to environmental justice communities, refer to Appendix A. Most of the existing incinerators in the U.S. are located in environmental justice communities that are disproportionately impacted by other polluting facilities. Many environmental justice organizations are actively involved in the advancement of alternatives to incineration which can provide economic and environmental benefits to their communities. In the next section, the economic vulnerabilities of the industry will be explored in detail.

Figure 7: MSW Incinerators and Environmental Justice Communities



Source: Global Alliance for Incinerator Alternatives (GAIA)

Environmental Justice Communities Advance Zero Waste & Just Transition Solutions

Environmental justice communities that host incinerators are not only opposing existing facilities, they are leading the way on alternative solutions to waste disposal. EJ organizers are proposing practical pathways toward phasing out incinerators and establishing zero waste systems. The zero waste goals proposed by EJ organizations include advocating for policies such as pay-as-you-throw, financial incentives for waste reduction, recycling, and composting, mandates for worker safety, and ensuring democratic participation of residents.

In Baltimore, resident activists are developing a Zero Waste Implementation Plan that phases out the Wheelabrator Incinerator and replaces it with alternative waste diversion industries like composting. The Plan defines the problem of incineration through a health, equity and racial justice lens and also details policy goals. EJ activists are building their network through the Fair Development Roundtable where they are advancing zero waste goals and community land trusts. The organizers will also support demonstration projects that highlight the deep commitment of residents to environmental sustainability by increasing composting and recycling as well as green space stewardship.[95]

EJ organizations are also deploying "Just Transition" principles in their efforts to move away from incineration towards zero waste goals. Just Transition refers to a set of principles, processes and practices of shifting economic and political power from an extractive economy toward, "a low-carbon and climate-resilient economy that maximizes the benefits of climate action while minimizing hardships for workers and their communities."[96] At the core of this approach is the fair treatment of workers in the transition, so that those that have been most negatively impacted by polluting practices in the past, directly benefit from future economic opportunities. In Detroit, local groups, including Breathe Free Detroit, sought protections for workers and residents as part of their campaign to shut down the Detroit incinerator.[97] They engaged with the city to hold it accountable for worker protection and raised funds for former employees.

Gentrification is another potential threat to local residents once an incinerator closes. EJ groups are raising awareness of the potential adverse impacts of the decommissioning process for shuttered incinerators and advancing Community Benefits Agreements (CBAs) to ensure that future development does not displace local residents. In Commerce, California, East Yard Communities for Environmental Justice is closely monitoring the decommissioning process after successfully advocating for the closure of the Commerce Refuse to Energy Facility.[98]

Chapter 2:
ECONOMIC INDICATORS OF DECLINE IN THE INCINERATOR INDUSTRY

The municipal waste incineration industry has profited by branding itself as a sustainable waste management and renewable energy industry. However, the industry relies on a risky business model that is costly to run and maintain as it ages, produces air pollution and toxic ash, and is dependent on public taxpayer dollars, which is ultimately not sustainable. The incineration industry in the United States is estimated to earn about $3 billion annually in gross revenue[99] and is expected to reach $4 billion in 2019.[100] Despite these profits, the industry faces serious economic challenges.

Two companies, Covanta and Wheelabrator, dominate the industry with 54 of the 73 "waste to energy" facilities under their control.[101] Incinerators are expensive to operate and maintain and "*the industry's performance is highly dependent on […] local and state government investment.*"[102] The incinerator industry relies on competitive tipping fee revenues and energy sales for a large proportion of its revenues. In order to secure funds from the sale of energy, the industry lobbies policymakers to secure access to tax credits, subsidies, power purchasing agreements, net metering, renewable energy credits and loan assistance through classification as a "renewable energy" source.[103] Even with these government supports; the industry still struggles to meet annual revenue demands. The vast majority of closures which took place over the past decade were due to economic losses.[104]

Figure 8 illustrates the financial structure of a typical MSW incinerator, showing capital investment sources, fixed and variable costs, and sources of revenue. Industry vulnerabilities are present in each of the quadrants depicted in the schematic. Incineration companies typically secure financing for the large capital costs of construction by securing publicly issued bonds or private loans. Wall Street firms have capitalized on this industry in which they profit from fees involved in structuring bonds that provide capital to build MSW incinerators. Between 1982 and 1989, Wall Street "floated $13.5 billion in bonds to build garbage incinerators and investment bankers earned nearly $200 million in fees."[105]

To get this financing, incinerator firms typically have to show evidence of economic viability by securing large, long-term sanitation contracts from county and municipal governments or other large institutions that can guarantee constant volumes of waste. Facilities built since the 1980s are relatively larger in size in order to guarantee enough volume of waste to be profitable. Incinerator revenues are derived largely from tipping fees; thus, these sanitation contracts are critical to their profitability.[106]

Despite rebranding themselves as energy companies, incinerators are primarily waste disposal companies. In addition to tipping fees, incinerators also sell steam and electricity as well as metal recovered from ash. The sale of energy from these plants has become another important stream of revenue as facilities capture more generous subsidies from the sale of electricity under the category of renewable energy. Energy sales account for approximately 20-30 percent of revenues and help cushion against decreases in tipping fees. As the 73 remaining incinerators age, the maintenance and upgrading costs also tend to increase and jeopardize a facility's profitability.

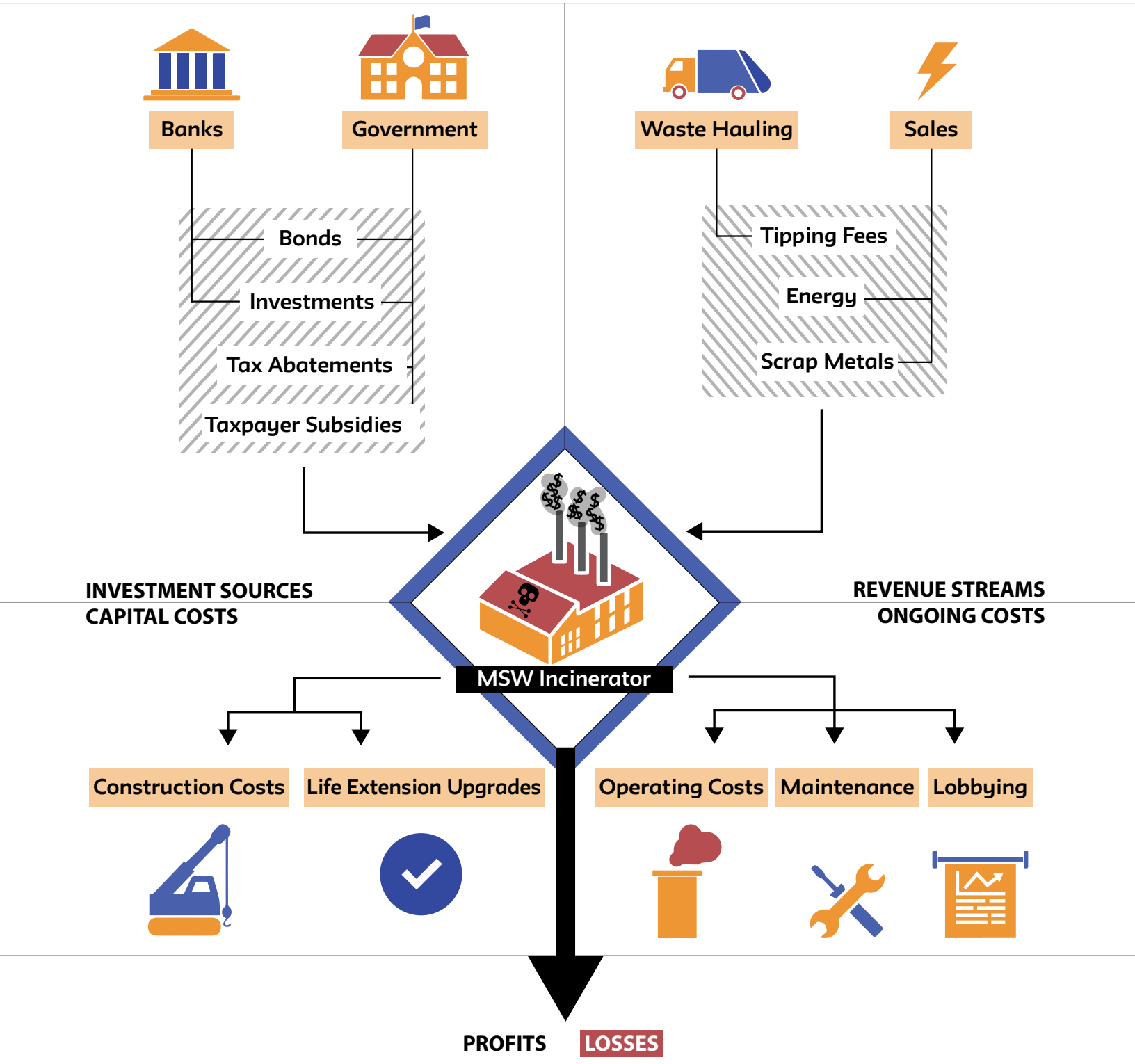
This report examines three major economic vulnerabilities in the MSW incinerator industry. First, construction and maintenance costs are significant and relatively more capital intensive compared to other forms of waste disposal. Second, the current pool of MSW incinerators have reached or are close to reaching their life-expectancy and now require another round of capital investment if they are going to continue operations, often at the expense and risk of local taxpayers. Third, the industry's revenue streams are volatile, dependent on competitive tipping fees and access to the renewable energy market.

Construction and Maintenance Costs

Incinerators are risky investments for cities[107], highly capital-intensive, and the most expensive form of garbage disposal. In order to raise the capital needed to build a new facility, companies often require assistance from government through various subsidies (companies typically qualify for some of these subsidies by being designated as 'electricity-generating' facilities) including access to low or no-cost municipal bonds.[108] Incinerator firms must first prove profitability to potential investors and local governments through executed service agreements with local governments, private waste haulers, and electricity purchasers.

According to the U.S. Environmental Protection Agency, construction of an average-sized incinerator can cost approximately $100 million.[109] However, construction costs often run well beyond $100 million. An MSW incinerator proposed for the Finger Lakes region of New York was estimated to cost $365 million to build and would have burned 2,640 tons of trash per day.[110] This facility proposal was halted in March 2019 because of community opposition and local lawmakers' concerns about the environmental and economic risks of the plant. High costs and community opposition have prevented hundreds of facilities from being constructed since the 1980s.[111] Only one facility in the U.S. has been built this century, the Palm Beach Renewable Energy Facility #2 in Florida.

Figure 8: Schematic of an MSW incinerator's financial structure



This facility was built in 2015 and is owned by the Solid Waste Authority (SWA) of Palm Beach County and operated by Covanta.[112] It cost $672 million to build and burns 3,000 tons of trash per day.[113]

Historically, municipalities issued bonds and used the proceeds to finance construction costs of a new facility. Although this is normal practice for states, counties, and cities looking to borrow money for major public projects like roads, schools, and hospitals, incinerator projects have proven to be risky public ventures. Christopher Taylor, formerly head of the Municipal Securities Rulemaking Board, told Reuters, in 2010, when reporting on the Harrisburg, PA incinerator, that, "*anybody who studied incinerator bonds for the last 30 years would find most of them had great difficulties, if not defaults.*"[114] The proceeds from bond sales are provided to the constructing company as a tax-exempt loan, anticipating that the bond debt will be repaid over time with revenues generated from tipping fees and electricity sales or from taxes.[115] One of the reasons Palm Beach County, Florida decided to support financing the construction of such an expensive facility, was in order to extend the life of their landfill by sending ash to the landfill, instead of solid waste.[116]

The large municipal bonds associated with incinerators are paid by local taxpayers and put municipalities at financial risk during construction and operation of an MSW incinerator. While incinerators may earn money for the owner/operator, costs are often borne by the public in the form of public financing and fees.[117] If the plant is unable to raise enough revenue through tipping fees or electricity sales to service the debt, taxpayers may be on the hook for the debt. In some cases, property taxes may be used to service the debt from construction.[118] At the Wheelabrator Westchester incinerator in Westchester County, New York, the county levied a property tax for solid waste services that provided $44 million in revenue to the incinerator company, or roughly 60 percent of the public solid waste budget, in 2009.[119]

Larger plants provide economies of scale that may make profitability more secure. It has been estimated that a larger facility may cost an average of $10/ton less to operate.[120] For host communities, larger plants mean increased air pollution from stack emissions and diesel sanitation trucks that service incinerators. The size of a WTE facility is dependent on the availability of MSW to burn and the ability to sell the net electrical generation.[121] At the Palm Beach Solid Waste Facility's Renewable Energy Facility #2 incinerator in Florida, the county planned to import waste from out-of-county waste haulers and therefore constructed a facility with excess capacity, meaning it was built to handle more waste than Palm Beach County alone produced. SWA and its operating partner planned to issue lower tip fees to out-of-county waste haulers than Palm Beach residents would pay, as an incentive to send their waste to the new facility, essentially putting residents in the position of subsidizing waste disposal for other municipalities.[122] This is a common practice, where facilities originally constructed via local bonds by county solid waste authorities with the purpose of handling the waste from municipalities in that county are constructed much larger than the volume of waste generated by the county. Communities that host these facilities are asked to not only bear the brunt of the pollution from the regional waste-shed, but also the debt and sometimes even disproportionate fees for waste outside their area.

Many incinerators negotiate contracts, or service agreements, with multiple municipalities in the region and/or private waste haulers to secure enough waste on a daily basis to feed the incinerator and raise enough revenue to stay in business. Historically, service agreements were executed for 20-30 year terms.[123] Municipalities may take these risks with the promise of reduced tipping fees for the host community and may be able to receive a "host fee," that returns some revenue to the municipality. For instance, Covanta pays Hempstead Town in Long Island, New York, an annual $7.7 million host fee for allowing them to operate the facility.[124] Harrisburg, Pennsylvania, also collects approximately $250,000 a year as a host fee from its incinerator, which according to state law is supposed to be used for environmental improvements.[125]

One of the worst examples of the financial burden that incinerators can have on municipal finances is the Detroit incinerator. In March 2019, operators of Detroit's infamous incinerator abruptly announced its closure. Detroit's incinerator struggled through decades of financial woes. In 1986, a total of $438 million was issued in bonds to build the facility, which opened in 1989 under city control.[126] At the time of closure, Detroit Renewable Energy CEO Todd Grzech reported, "…*when we looked at it, there was just not enough money in the world to be a good neigh-*

bor, create value for our customers and go forward as a business entity. It just doesn't all match up."[127] After more than 30 years, the Detroit incinerator ended up costing local taxpayers close to one billion dollars to construct, operate and maintain over time due to the significant debt financing that was paid on the original bonds.

In addition to the high capital costs for construction, MSW incinerators are very expensive to operate and maintain and may leave operators/owners with tight margins and operating deficits. The U.S. Energy Information Administration reports that the fixed operating and maintenance (O&M) costs for running an MSW incinerator makes it the most expensive way to generate electricity.[128] In order to estimate the Annual Operating and Maintenance Costs for an average MSW incinerator, three methods were used: (1) the World Bank estimates of operation and maintenance costs for a median size incinerator based on average tonnage and tip fees, (2) the U.S. Energy Information Administration (EIA) estimates of waste burning based on costs per kilowatt-year, and (3) an example case of the York County Resource Recovery Facility in Pennsylvania using publicly available financial records. Table 2 summarizes these methods and the resulting estimates of operation and maintenance costs (see Appendix B for complete calculations).

According to the three different methods, average operation and maintenance (O&M) costs for incinerators fall within a range of $17-$24 million annually. These fixed costs are relatively high in relation to the profit margins that incinerators like the York facility may expect on average. In order to compare the profit margins and fixed costs that most incinerators face, Table 3 summarizes the annual revenue and expenses for the York County Resource Recovery Facility in Pennsylvania. This is a 30-year-old, mid-sized facility publicly-owned and privately-operated by Covanta. Pennsylvania treats trash burning as 'renewable energy' through its net-metering policy and Renewable Portfolio Standard. The facility has the capacity to incinerate 1,344 tons of waste per day and its tipping fee is $62 per ton,[129] which falls in the average range for MSW incinerators. Its gross annual electricity generating capacity is 42 MW. This facility was selected because its annual waste capacity is close to the median value of all MSW incinerators, and since it is publicly owned, its financial reports are publicly available.

The profit margins of this plant are notably thin at approximately $1.2 million annually. Without electricity sales totaling over $9 million, the facility would not raise enough revenue from tipping fees to meet annual operating and maintenance costs. This case study illustrates the incinerator industry's increasing reliance on electricity sales to cushion their tipping fee revenues and offset the potentially increasing O&M costs as the plant ages. If tipping fees fall by as little as 15-20 percent, or the O&M costs increase by the same amount, the facility would no longer be profitable. Some municipalities are forced to cover operating deficits for failing incinerators. In 2016, Covanta's Pittsfield Resource Recovery Facility threatened to close its Pittsfield, Massachusetts facility because of high operating costs and declining profitability. Pittsfield lawmakers passed incentives totaling $562,000, coming from an economic development fund, for the company to stay open for at least another four years.[130]

Life-Extension of Incinerators

Most MSW incinerators currently in operation today were built in the 1980s. The average age of these facilities is 31 years[131] yet the average life expectancy of an incinerator is 30 years.[132] Upgrading decades-old facilities requires another large capital investment, often paid for or subsidized by local taxpayers. The age of these facilities can be a major contributor to equipment breakdowns, shut downs, fires and permitting violations under the Clean Air Act. Upgrad-

Table 2: Cost Calculations for Average Annual Operation & Maintenance Costs for MSW Incinerators

SOURCE	ESTIMATE OF O &M (ANNUAL $)
World Bank estimates for median size incinerator based on tonnage & fees[278]	(1,050 tons/day x 365 days x $44-$55/ton) = **$17 million - $21 million**
U.S. EIA estimates of waste burning costs per kilowatt-year[279]	$392,820 X 61 MW = **$24 million**
York County Resource Recovery Facility	Publicly available financial records[280] **$20,440,360**

Table 3: York County (PA) Incinerator Revenues & Expenses (2017)

REVENUES (ESTIMATE)		EXPENSES (ESTIMATE)	
Tipping Fees	$24,320,550	Operation & Maintenance	$20,440,360
Electricity Sales	$9,350,730	Processing Fee	$716,640
		Misc. Operating Costs	$11,330,020
TOTAL	**$33,671,280**	TOTAL	**$32,487,020**

ing air emissions control technology is particularly expensive and requires large capital investments, typically generated from additional municipal bonds. Municipalities that finance upgrades with bonds use the proceeds from the bonds to loan to the operating company. For example, in Niagara Falls, New York, a Covanta-owned facility received $165 million from the municipality for upgrades in 2012, which served as a tax-exempt loan for the company.[133] In 2015, Niagara Falls Covanta received two new fixed rate tax-exempt corporate bonds totaling $130 million.[134] At the Essex County facility in Newark, New Jersey, the Essex County Improvement Authority issued $90 million in bonds in 2015, to mature in 2045, to finance the upgrade of the facility's emissions control technology to a baghouse.[135] Covanta's Delaware Valley facility in Pennsylvania accessed $40 million in public bonds and partially used it to refinance the debt from upgrading projects at its facility.[136] In Red Wing, Minnesota, a $12.54 million upgrade for the incinerator will be funded by Xcel Energy and the City of Red Wing, with 62 percent of the total cost covered by the City.[137]

The most infamous example of financially ruinous investments in incinerator upgrades can be found in Harrisburg, Pennsylvania. Between 1969 and 2003, the City of Harrisburg issued 11 sets of bonds to build, expand or repair the incinerator facility. In 2003, due to excessive dioxin emissions, the U.S. EPA threatened to shut down the plant.[138] By this time, the facility already held more than $100 million in debt. Instead of shutting down the facility, then Mayor, Stephen Reed, and his administration chose to retrofit it using $130 million in city-backed debt. This debt became a financial nightmare for the city leading to a major budget deficit that caused government layoffs, a 17 percent increase in property taxes and an attempt at Chapter 9 bankruptcy.[139]

A court decision blocked the bankruptcy.[140] However, the Governor intervened and declared a fiscal state of emergency. In 2018, the state filed a lawsuit against responsible parties, including law firms and private investors, who made millions of dollars in fees from structuring this financial debacle. At the time the suit was filed, Governor Tom Wolf released a statement:

> *"It is time to hold those responsible for the failed incinerator debt scheme accountable and recoup the taxpayer dollars wasted by their negligence and deception. This project, started in 2003, represents the worst of how lobbyists and special interests bill taxpayers for their own gain."*[141]

Fire and Accidents

As incinerator facilities age, the incidence of equipment failure or poor operating practices can lead to fires, failures or other accidents at the facility. Flammable, reactive or toxic materials may enter the incinerator via the tipping floor where trucks dump materials before entering the furnaces. These materials may ignite on the tipping floor or in the pit where sparks from materials such as a decaying battery, or spontaneous combustion of organic material.[142] During incineration, chemicals that are incompatible might react and generate heat or produce flam-

The Harrisburg Incinerator on South 19th St.
Source: PennLive, Paul Chaplin, The Patriot News/file.

mable, toxic, or inert gases or mixtures that produce toxic substances, fires, or explosions. These incidences may indicate poor management and declining operations within a facility.

Even if facilities are upgraded, the risks of fires, accidents, equipment failure, and breakdowns can persist. The Montgomery County Resource Recovery Facility in Dickerson, Maryland, is 22 years old and among the newest MSW incinerators in the country. In recent years, however, it has experienced increasing equipment issues and at least six waste pile fires between 2015 and 2017.[143] The waste-to-energy facility in the city of Hartford, Connecticut was the primary waste facility for the state but was fully offline after both turbines broke on November 5th, 2018. An estimated 20,000 tons of waste had to be stored indoors and pre-processed waste was also held in outdoor containers, in violation of state permits.[144] The facility's aging equipment is prone to unplanned outages and Connecticut's quasi-public agency, the Materials Innovation and Recycling Authority (MIRA), previously warned state officials that it would be unable to bear the costs of needed upgrades.[145] According to MIRA officials, member municipalities could see tip fees increase from approximately $72 per ton to $83 per ton by March 1, 2019, to help offset the millions of dollars in extra costs generated by the equipment failure.[146]

The federal government does not collect or maintain a central repository of reports on fire incidences or other accidents in the incineration industry. In order to compile information on incinerator fires and accidents, a search of local newspaper articles reporting these incidences in nearby facilities was tabulated. Four notable incinerator fire accidents were identified since 2008; (1) Montgomery County Resource Recovery Facility in Maryland; (2) Covanta Fairfax County incinerator in Virginia, (3) Spokane City incinerator in Washington, and the (4) Bay County incinerator in Florida.

In December 2016, there was a trash fire inside the Montgomery County Resource Recovery Facility (24 years old, burns 1,800 tons MSW/day) in Maryland which lasted almost two weeks. A "tower of trash eight stories high and 200 feet wide" caught fire in the 30-foot-deep storage pit. The county warned residents living within a mile of the plant to stay indoors or leave the area if they had asthma, lung or heart issues.[147] The Covanta Fairfax County incinerator in Virginia (29-years old facility, burns 3,000 tons MSW/day) experienced a fire that lasted multiple days in February 2017, causing regional concern about air quality. Fire investigators determined that the fire originated on the tipping floor of the building and extended to the holding pit which was filled to capacity at three stories high.[148]

Source: Photo taken by Ari Herzog at Haverhill Resource Recovery Facility in Haverhill, Massachusetts, September 17, 2008.

Vulnerability in Revenue Stream

The incineration industry in the U.S. operates in a volatile economic and regulatory environment. The industry's profit margins are tight, and they rely on steady streams of waste with accompanying tipping fees and generous energy subsidies to ensure their profitability. According to Covanta's 2018 Annual Report,

> *"We also expect that an increasing portion of system capacity will be contracted on a shorter term basis, and so we will have more frequent exposure to waste market risk...As our historic energy contracts have expired and our service fee contracts have transitioned to tip fee contracts, our exposure to market energy prices has increased."*[149]

This volatility coupled with debt burdens and fixed or increasing maintenance and operating costs makes this industry particularly vulnerable to decline as incinerators reach the limits of their life expectancy. Municipal solid waste incinerators rely primarily on tipping fees and secondarily on electricity sales for revenues. As an example, Covanta (which owns 22 facilities and operates 39 facilities in the U.S.), on average, derives its revenues: 71 percent from tipping fees, 18 percent from electricity sales, 5 percent from metal recycling and 6 percent from "other" (i.e. revenues derived from construction revenues, resale of purchased energy, fees from operating transfer facilities, etc.).[150] This distribution of revenues seems to be common among the industry and electricity sales have become an important component in shoring up the profitability of the industry as waste volumes and tipping fees fluctuate. But the market for WTE electricity as a "renewable" energy has also fluctuated as regulatory environments shift. If renewable energy subsidies decline or become unavailable, incinerators may quickly go out of business. Additionally, if new climate mitigation policies that regulate, or price carbon are applied to the incineration industry, it threatens the economic viability of these plants.

Tipping Fees

Tipping fees are the most significant revenue for MSW incinerators and represent one of the most vulnerable parts of their revenue stream. "Tipping fees" or gate fees, are charged by a waste disposal site, such as an incinerator or landfill, to a municipality or private waste hauler for each tonnage of waste deposited at the site. Incinerators are dependent on a steady waste volume and seek to burn waste at their maximum capacity to remain profitable. The more trash they burn, the more revenue they can generate. These tipping fees vary greatly from facility to facility depending on a variety of factors. One important factor is the going price in regional markets where tipping fees at landfills, which are direct competitors for incinerators, can set the lower boundary for fees. If a city or hauler has the option to dump its waste in an incinerator or in a landfill, they will often turn to the lowest cost option in their locality (factoring in transportation costs).

Thus, landfill tip fees are important markers that can outcompete incinerators for trash volumes. Tip fees also vary across the country based on the amount of available, cheap land for landfills. According to *Solid Waste Environmental Excellence Protocol (SWEEP)* 2016 tip fee survey, the average landfill tipping fee was $49, and the following regional trends persisted: "*Regional trends remained the same, with the highest costs in the Northeast and the lowest in the West. Approximate average tip fees at the end of 2016 were $78 in the Northeast, $57 in Pacific states, $48 in the Midwest, $41 in the Southeast and $35 in the West.*"[151] In places where tipping fees at landfills decline or where volumes of waste decrease, incinerator tipping fee revenues can be jeopardized. For example, in New Jersey, Covanta recently closed their Warren County Resource Recovery Facility because of the decline in tip fees as reported in their 2018 Annual Report.[152]

Tipping fees can also vary across different sanitation contracts within the same facility. For instance, trash hauled from Olmsted County to the Rochester, Minnesota facility is set at $83 per ton.[153] Yet waste haulers from Dodge County to the same facility pay about $108/ton or 30 percent more. Dodge County is further away at 23 miles from the facility, while Olmsted County is roughly 7 miles away. In order to ensure incinerators raise enough revenue through tipping fees, municipalities often agree to "put or pay" clauses with incinerators. These clauses stipulate that communities must supply a certain amount of waste or pay a penalty. This guarantees a set revenue stream regardless of the quantity or quality of waste delivered, and it creates a significant financial obligation for the city. These clauses are also criticized by environmental advocates who point to the perverse incentives embedded in these agreements to undermine diversion of waste to more sustainable disposal options like composting or recycling. One

example of the financial costs and perverse incentives that these clauses create for waste diversion can be found in Honolulu, Hawaii. The City of Honolulu has a 20-year "put-or-pay" contract with the Covanta incinerator (HECO) to deliver 800,000 tons of waste annually to the facility or face steep financial penalties.

> *"From 2013 to 2016, the city had to pay Covanta over $6.2 million, according to an audit (PDF) of the city's recycling program released in October. Honolulu could save $7 million in disposal costs and generate $29.5 million in revenue by diverting its plastic and paper recycling from the H-POWER facility. The city also has a profit-sharing arrangement with Covanta for energy sold to HECO, which some see as a perverse incentive to produce more waste rather than less."*[154]

In April 2019, Wheelabrator filed suit against Baltimore County for breaching their sanitation contract by not sending enough waste to their facility and claiming defendants caused over $32 million in damages.[155] "Put or Pay" clauses lock a municipality into generating waste at levels that do not allow for meaningful increases in diversion or waste reduction, following the U.S. EPA's waste hierarchy. A 2011 study found 65 percent of incinerated waste could have been recycled or composted.[156] Burning trash directly conflicts with recycling and composting goals and is a hindrance to local and state Zero Waste targets.[157]

Some cities have caught on to the financial and environmental burden of these "put or pay" clauses and begun re-negotiating contracts. For example, the City of Bridgeport, Connecticut, previously had a "put or pay" contract with the Wheelabrator incinerator but in 2018, when a new contract was signed with the company the city removed this clause. The Housatonic Resources Recovery Authority Executive Director in Bridgeport emphasized that the contract "creates no risk of financial exposure to the town," explaining that eliminating the practice of put-or-pay as one of the major advantages of this new contract.[158]

In order to better understand the vulnerability of incinerators to price fluctuations in tipping fees, the fees for 54 of the 73 MSW incinerators were compiled (Tip fees for 19 facilities were not publicly disclosed or available. For a complete list of tip fees and source information please see Appendix C).[159] Using these fees, the average incinerator tipping fee nationally was estimated to be about $65.35/ton. The national average for landfill tipping fees is approximately $51.82/ton.[160] However, the national average for landfill tipping fees for states *with* incinerators was estimated to be higher at $63.26, as shown in Table 5. Tipping fees for incinerators range from $15/ton of waste for Detroit's former incinerator to as high as $130.55/ton for Covanta's Essex County incinerator in Newark, New Jersey (this tip fee is for some haulers bringing waste from outside of Essex County). The market for waste disposal is regional and many waste haulers export waste to other states, particularly in the Northeast where there is less available landfill space. This dataset represents an estimate of the tipping fee market at a state scale, but regional tipping fees may diverge from this.

Table 4 compares average landfill tipping fees to estimated average incinerator fees by state. In about half the states, the difference between the average landfill tipping fee and the average incinerator-tipping fee is relatively small, which means incinerators in these markets are likely competing head to head with landfills for waste. If incinerator tipping fees increase or landfill fees drop, incinerator revenues could be jeopardized.

> *"The biggest impediment for us is cheap landfilling, particularly in the middle part of the country," Covanta's Van Brunt says. Tipping fees can be as low as $20 per metric ton in land-rich states like Oklahoma. More densely populated coastal regions tend to have more waste-to-energy facilities because of their landfills' relatively high tipping fees—more than $70 in parts of New Jersey, for instance."*[161]

Hawaii, Massachusetts, Maryland and New Hampshire have much higher landfill fees than incinerator fees. This may be due to a lack of landfills or available landfill space within a state, or regionally. The costs of exporting waste might also be much higher, adding to the relative cost of landfilling. Hawaii, for example, will pay much more for out of state export of waste to landfills than a state in the middle of the U.S. In Minnesota, New Jersey, Washington, and Wisconsin, incinerator fees appear much higher than landfill fees. Northeast states have some of the most expensive landfill and incinerator tip fees. This is likely because of the high volumes of waste and shortage of available land compared to other parts of

Table 4: Average Landfill Tip Fees Compared to Average Incinerator Tip Fees by State

States	# Incinerators	Incinerator Tip Fee Data Points	Average Incinerator Tip Fee (i)	Average Landfill Tip Fee (ii)	Difference Between Average Landfill & Incinerator Fees
Alabama	1	1	$40.00	$33.49	($6.51)
California	2	2	$59.50	$58.42	($1.08)
Connecticut	5	3	$65.67	NA	NA
Florida	11	9	$55.36	$54.67	($0.69)
Hawaii	1	1	$45.00	$96.33	$51.33
Iowa	1	1	$55.00	$48.28	($6.72)
Indiana	1	0	NA	$45.02	NA
Massachusetts	7	4	$68.48	$95.00	$26.52
Maryland	2	2	$55.00	$68.28	$13.28
Maine	3	3	$78.83	$78.20	($0.63)
Michigan	2	2	$35.00	$37.81	($2.81)
Minnesota	7	5	$83.20	$61.67	($21.53)
New Hampshire	1	1	$64.00	$80.00	$16.00
New Jersey	4	4	$81.96	$97.43	($15.47)
New York	10	5	$76.82	$66.17	($10.65)
Oklahoma	1	0	NA	$34.81	NA
Oregon	1	0	NA	$69.58	NA
Pennsylvania	6	5	$66.35	$69.59	$3.24
Virginia	4	3	$59.14	$53.48	($5.66)
Washington	1	1	$107.53	$83.44	($24.09)
Wisconsin	2	2	$64.00	$49.09	($14.91)
TOTAL/AVERAGE	73	54	$65.63	$63.26	($2.09)

* Numbers in red parenthesis indicate amount that average incinerator tip fees exceed landfill tip fees in respective states.

(i) Staley, Kantner, and Choi, Analysis of MSW Landfill Tipping Fees, 1-5.

(ii) Average landfill tip fees serve as a proxy for regional waste management prices. States can export waste to landfills out of state in the region which may have different tipping fees from in-state facilities.

the country. These higher tip fees may also be a result of lucrative, long term sanitation contracts with large metropolitan cities in the region that can export their waste easily to nearby receiving incinerators. While tipping fees are subject to regional market changes and the terms of specific sanitation contracts, the relatively small differences in price between landfill and incinerator tipping fees means that there is strong competition in the market for waste and incinerators are at a significant risk if these prices or waste volumes drop.

Electricity Sales

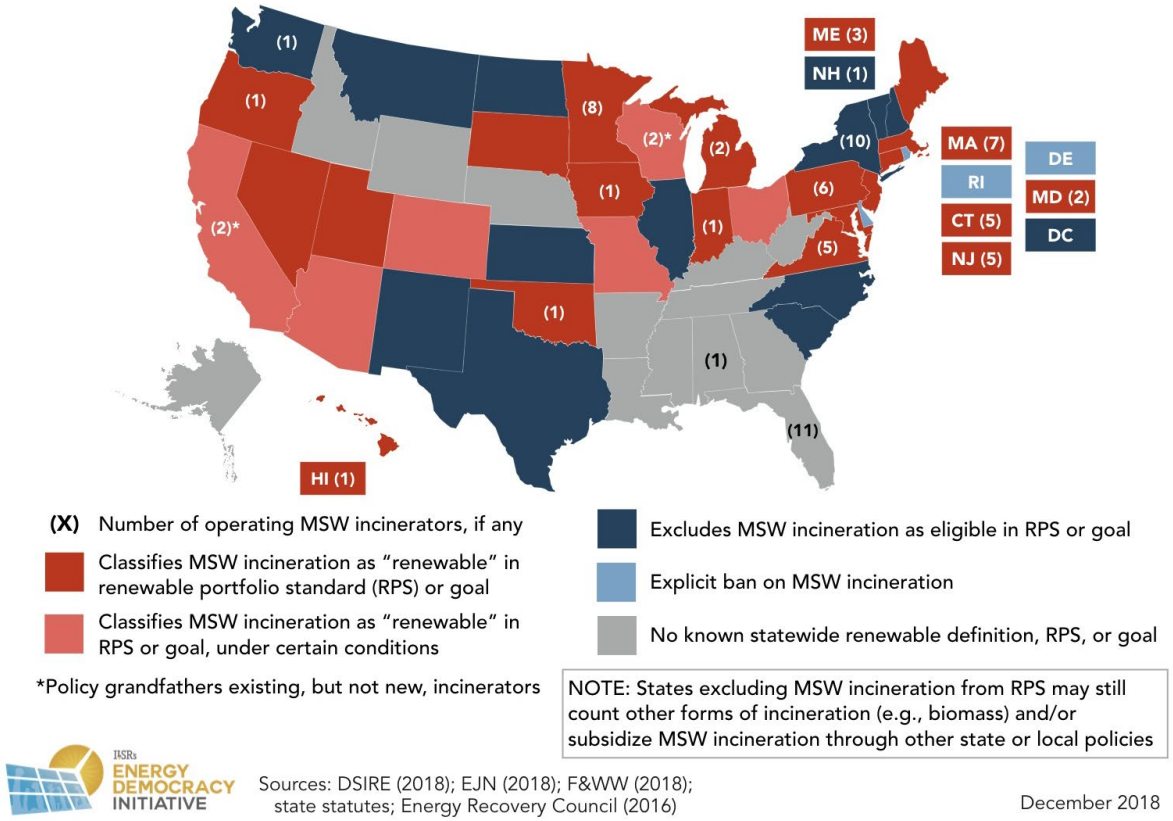
In addition to tipping fees, incinerators depend on sales from electricity generation to boost their revenues. MSW incinerators produced a negligible 0.4 percent of total U.S. electricity generation in 2015.[162] Electricity sales serve to augment the gap between operating costs and tipping fee revenues.[163] However, burning trash is one of the most expensive forms of energy generation in the U.S., with higher capital and fixed costs compared to other energy sources, including wind, solar, natural gas, coal and even nuclear power.[164] For example, waste incineration costs $8.33/MWh compared to $4.25/MWh for pulverized coal and $2.04/MWh for nuclear, the second and third most expensive forms of energy generation.[165] The incineration industry has taken advantage of lucrative renewable energy subsidies because the U.S. EPA and several states have allowed waste incineration to be defined as a "renewable energy" source.

State Renewable Portfolio Standards (RPS) are one example of the way in which states have allowed waste incineration to benefit from the increased interest in investing in renewable energy.[166] Thirty-seven states and the District of Columbia have an RPS.[167] RPS programs set renewable electricity generation targets and define allowable technologies, such as solar and wind that qualify as renewable. Qualifying producers are authorized to sell electricity generated beyond their required obligation and may trade or sell renewable energy credits (RECs), typically receiving one REC per MWh of power produced each year.[168] Twenty-three states include municipal solid waste incineration as a "renewable" form of energy.[169] How much capital is allocated to renewable energy sources depends on what "tier" within the RPS it is placed. Tier I generates more revenue than Tier II, and although most states place incinerators in the Tier II category, the designation grants incinerators valuable access to the renewable energy markets.[170] Only Maryland classifies incineration as a Tier I source of renewable energy on par with solar and wind and this designation was likely a factor in catalyzing a proposal to build a new MSW incinerator in Baltimore that was defeated by local residents.

Figure 9 shows which states have an RPS, if it includes MSW incineration, and the number of MSW incinerators in each state. According to this report, 52 incinerators are located in states that include MSW incineration as an allowable technology; however, at least three of these facilities have closed since the report was published in 2018 (in Minnesota, Michigan, and New Jersey) making the current total 49.[171] Two thirds of all the incinerators in the U.S. today have access to renewable energy subsidies that contributes to the profitability of these plants.

These same subsidies are under increased pressure from advocates to be eliminated or significantly curtailed. In Gonzalez, California, residents opposed a potential waste-to-energy facility that sought access to the state's renewable energy credits. California includes one of two existing MSW incinerators in the state RPS as an allowable technology. When the company behind the proposed facility failed to persuade state officials to include them in the RPS, the

Figure 9: Number of MSW Incinerators included in RPS by State



Source: Institute for Local Self-Reliance, "Waste Incineration: A Dirty Secret in how States Define Renewable Energy."

company withdrew their proposal.[172] This example illustrates the power of advocates to threaten the industry's renewable energy subsidies.

Burning trash is not a renewable or "clean" source of energy. Incineration releases greenhouse gases into the atmosphere, contributing to climate change. MSW incinerators may be at-risk from climate mitigation policies that put a price on carbon pollution such as a carbon tax. Covanta recently reported that if New York State passes a proposed carbon tax bill, they may need to close four incinerators on Long Island because of increased costs.[173] Referring to the potential impacts of a new carbon tax on their business, an industry representative highlighted the likelihood of plant closures with the lack of exemptions for incinerators in the bill:

> *"It's a pretty brutal policy" for waste-to-energy plants, said Scott Henderson, senior director of government relations for Covanta, which estimates the four waste-to-energy plants it operates on Long Island would incur between $31.1 million and $42.7 million a year in new costs as a result of the policy. The combined $332 million in costs over 10 years Covanta expects to incur from the carbon pricing plan "will likely result in waste-to-energy facilities closing."* [174]

These significant costs to meet carbon emissions reductions targets reflect how much carbon pollution is emitted from burning waste. The industry has long argued that their emissions should be considered carbon neutral because they burn waste that is biogenic, hence the carbon they emit would have cycled into the atmosphere in the form of decomposition over time. But MSW incineration delivers a burst of carbon in a short time span (as opposed to natural decomposition over years) and they also burn increasingly large proportions of non-biogenic waste made from fossil fuels like plastics, which contributes to GHG emissions and co-pollutants.[175] The United Nations Environment Programme (UNEP) challenges the carbon neutrality logic of waste incineration:

> *Climate change is time-critical – it is widely accepted that immediate reductions in global GHG emissions are essential to reduce the impact of climate change. The atmosphere does not differentiate between a molecule of biogenic CO2 and a molecule of fossil-derived CO2, therefore it appears logical that immediate efforts should be made to minimize emissions of all CO2 regardless of source.*[176]

Incineration of non-biogenic waste like plastics produces toxic compounds detrimental to human health. Burning organic waste also produces more carbon dioxide than coal-fired power plants.[177] In either case, biogenic or non-biogenic, waste is not a renewable source of energy and thus advocates have rightly criticized industry efforts to exploit these subsidies to the detriment of actual renewable sources. The incineration industry faces the possibility of continuing to lose access to valuable renewable energy subsidies which puts their whole revenue model at risk.

Net metering is another way the industry has used its identification as a renewable energy source to buttress its financial sustainability. Net metering is designed to promote the expansion of renewable energy by allowing renewable energy generators to sell their excess energy to a utility.[178] As of 2015, 44 states have net metering policies. According to the DSIRE database, 14 states and three cities include municipal solid waste incineration in their net metering regulatory policies.[179] As of 2015, 44 states had net metering policies. According to the DSIRE database, 14 states and three cities include municipal solid waste incineration in their net metering regulatory policies. In 2018, the outgoing Republican Governor in New Jersey, Chris Christie, signed a bill, AB 2204, that extended net metering to MSW incinerators and allowed them to sell power directly to up to 10 end-use customers located within 10 miles of the facility.[180] These net metering subsidies can give incinerators unfair access to renewable energy subsidies and deflect important resources from truly renewable energy technologies like solar and wind.

Community Victory: Commerce Incinerator Closure

In June 2018, a waste incinerator, in Commerce, California, named the Commerce Refuse-to-Energy Facility was permanently shut down. The Covanta run facility began operations in 1987 burning over 120,000 tons annually of municipal solid waste. When the facility was originally proposed, it was promoted by the City of Commerce and County Sanitation Districts of Los Angeles as a state-of-the-art alternative to landfilling in Los Angeles County. This incinerator reflects the weak financing model for an industry that has become increasingly dependent on renewable energy subsidies to stay afloat. The facility spokesman stated,
"It really was all because of the expiration of a 30-year power purchase agreement we had with the local utility, Southern California Edison, that expired on December 31, 2016, he said, explaining this cut previous rates of 11 cents per kWh by nearly two-thirds. 'That was insurmountable.' CREA raised tip fees to $84, as far as the local market would allow when factoring in cheaper rates at nearby landfills, but that wasn't enough. Energy comprised two-thirds of the plant's revenue model" (Charles Boehmke, LASDC).[181]

The industry attempted, over the last decade, to lobby California state lawmakers to consider incineration on par with renewable energy sources like solar in order to capture valuable renewable energy subsidies. These efforts were effectively thwarted by community and environmental justice advocates' opposition. East Yard Communities for Environmental Justice is a community based environmental justice organization that works together with community members in East Los Angeles, Lynwood and Long Beach. This group fought alongside the community in opposing the incinerator and advancing calls for the closure of the plant siting both the financial and health impacts on nearby residents. In 2017, East Yard Communities for Environmental Justice together with Valley Improvement Projects quickly organized to prevent incineration from qualifying for renewable energy subsidies. In June 2018, the owners closed this plant because of rising costs without any new forms of revenues.

The final closure of the Commerce incinerator shows that the sustained efforts by EJ advocates can effectively curtail the incineration industry's fiscal viability by removing renewable energy subsidies from the equation. The advocates are continuing their efforts in shutting down another local incinerator in California, as there are two remaining facilities, both operated by Covanta. East Yard Communities for Environmental Justice has been actively opposing another local incinerator, the Southeast Resource Recovery Facility, a 30-year-old incinerator in Long Beach, CA. Community organizers have been putting pressure on the incinerator and potential revenue streams, which included defeating a bill qualifying incineration as renewable energy, monitoring air emissions records, raising awareness of the potential health impacts of incinerators on low-income communities and communities of color, and opposing financial incentives by the City for Covanta. Despite the Long Beach City Council's recent decision to provide financial support for costly upgrades of the aging facility, the voices against these public investments and the increasing call for zero waste are gaining strength. The financial vulnerability and the declining nature of the incineration industry was clearly demonstrated in the case of the Commerce incinerator.

Power Purchase Agreements

Power Purchase Agreements (PPAs) are another way incinerators' boost their revenue through electricity sales. PPAs are contracts between an electricity provider and a power purchaser, typically a utility or trader, in which the purchaser commits to acquiring a certain amount of energy. This long-term contractual commitment to buy energy has been the driving factor behind the development of new projects.[182] Examples of cities that have entered PPAs with MSW incinerators include the District of Columbia; Palo Alto, California; Georgetown, Texas; and Pendleton, Oregon.[183]

Sometimes electricity prices drop or PPA agreements expire and are not renewed. This puts the facility at financial risk. Spokane, Washington's city-owned incinerator previously sold its electricity to Puget Sound Energy for about $12 million per year in revenue.[184] However, the agreement expired in 2011, and a state law the following year removed MSW generation from the qualified list of renewables. Now the Spokane incinerator sells its electricity to Avista, for 3.8 to 5.2 cents per kilowatt-hour, lower than the 9 cents per kilowatt-hour agreement with PSE.[185] Under this new agreement, the Spokane incinerator will earn roughly 58 percent less in electricity sales.

The Miami-Dade County Resource Recovery Facility sold electricity through a Power Purchase Agreement with Florida Power & Light until 2013 when the agreement expired. Electricity sales revenues dropped from slightly over $30 million in 2013 to $14 million in FY2014. After the PPA expired, the rate dropped from $85 per megawatt hour to the market rate of about $28 per megawatt hour.[186] The Commerce, California, incinerator shuttered in 2018 as a direct result of the expiration of its power purchase agreement, a year after legislation aimed at providing incinerators with renewable energy subsidies failed to pass. These examples reflect the vulnerabilities inherent in facilities that rely on these contracts and the power of advocates to challenge the incineration industry's claims to renewable subsidies.

Closures and a Future in Decline

The incinerator industry is in trouble. Aging facilities are often too expensive to maintain, too risky to finance and too costly to upgrade. These plants operate under volatile economic and regulatory conditions that threaten their major sources of revenue, tipping fees and energy sales. Since 2000, at least **31 MSW incinerators closed,** largely due to economic factors. Table 5 lists all 31 facilities and the primary reasons for closure. For eighteen of the facilities listed in Table 6, related news articles sited economic conditions for closing, particularly a decrease in revenue from either loss of tipping fees or electricity sales. Some facilities also cited an insufficient waste stream. According to news reports, six of the facilities closed because they were unable to afford the necessary upgrades in air pollution control equipment (Davis Energy Recovery Facility, Harrisonburg WTE Facility, Southernmost WTE Facility, Miami Incinerator and Nottingham Incinerator). In North Charleston County, South Carolina and Ossipee, New Hampshire, both municipalities shut down their incinerators as part of their strategy to increase recycling and improve environmental management systems. In Detroit and Dearborn Heights, Michigan, facility operators included community opposition as part of the reason they shut down.

Advocates and local environmental justice communities are increasing the pressure on states and cities to reject new incinerators, as well as tighten the requirements and reduce access to subsidies for existing facilities. The combined pressures from increasing costs, risky revenue streams and environmental justice advocacy and zero waste policies creates a picture of an industry in decline. In the following chapter, a review of the health implications and risks associated with this declining industry is explored in depth.

Table 5: Incinerator Closures Since 2000

Facility Name	Location	Year of Closure	Reason(s) for Closure
Detroit Renewable Power	Detroit, MI	2019	Economic conditions[281]
Great River Energy - Elk River Station	Maple, Grove, MN	2019	Economic conditions[282]
Covanta Warren County Resource Company Facility	Oxford, NJ	2018	Economic conditions[283]
Commerce Refuse-to-Energy	Commerce, CA	2018	Economic conditions[284]
Davis Energy Recovery	Layton, OH	2017	Upgrades[285]
Little Miami Waste Incinerator	Hamilton County, OH	2016	Upgrades
Harford Waste-to-Energy	Joppa, MD	2016	Economic conditions/loss of contract[286]
Wheelabrator North Broward	Pompeo Beach, FL	2015	Economic conditions[287]
Wallingford Resource Recovery	Wallingford, CT	2015	Economic conditions/Emissions violations[288]
Harrisonburg Resource Recovery	Harrisonburg, VA	2014	Economic conditions/upgrades[289]
Jackson County Resource Recovery	Jackson, MI	2013	Economic conditions/loss of contract[290]
Wheelabrator Claremont	Claremont, NH	2013	Economic conditions[291]
Coos County Beaver Hill Municipal Waste Incinerator	Beaver Hill, OR	2012	Economic conditions[292] /Safety hazard[293]
Maine Energy Recovery Company	Biddeford, ME	2012	Lack of owner interest[294] /odor complaints[295]
New Hanover County - WASTEC	Wilmington, NC	2011	Economic conditions[296],[297]
Montenay Waste-to-Energy Recycling	North Charleston, SC	2010	Emissions violations[298] / Recycling[299]
Ossipee Solid Waste Incinerator	Ossipee, NH	2009	Recycling mandate[300]
Candia Incinerator/Recycling Center	Candia, NH	2008	Loss of contract[301]
Savannah Resource Recovery	Savannah, GA	2008	Economic conditions[302]
Fergus Falls Resource Recovery	Fergus Falls, MN	2006	Economic conditions[303]
Park County-Livingston Incinerator	Livingston, MT	2005	Emissions violations[304]
Juneau Incinerator	Juneau, AK	2004	Economic conditions[305]
Harrisburg Resource Recovery*	Harrisburg, PA	2003	Economic conditions/Emissions violations[306]
Central Wayne Energy Recovery L.P.	Dearborn Heights, MI	2003	Economic conditions/Emissions violations [307],[308]
Southernmost Waste to Energy	Key West, FL	2002	Air Pollution Control Upgrade cost[309]
Osceola Incinerator	Osceola, AR	2002	Federal Fraud Conviction[310]
Pascagoula Energy Recovery	Moss Point, MS	2002	Economic conditions[311]
Sutton Incinerator	Sutton, NH	2001	Unknown[312]
Miami Incinerator	Miami, OK	2000	Emissions violations/Upgrades[313]
Nottingham Incinerator	Nottingham, NH	2000	Upgrades[314]
Sitka Waste-to-Energy	Sitka, AK	2000	Unknown[315]
Hebron-Bridgewater Refuse District	Bristol, NH	Unknown	Unknown[316]

*Harrisburg, PA facility reopened in 2006 after major upgrades.

Chapter 3:
PUBLIC HEALTH AND COMMUNITY IMPACTS

Waste incinerators produce a variety of pollutants from the combustion of municipal solid waste, to the transport of the waste via diesel sanitation trucks to the ash that is a byproduct of the combustion process. The heterogenous nature of MSW means that waste incinerators are burning a variety of consumer waste laden with heavy metals and other toxic compounds that results in the release of harmful air pollutants when combusted. Populations in close proximity or downwind to the facility may be exposed directly through inhalation of air pollutants or indirectly through consumption of contaminated food or water.

Despite air pollution control technologies and regulatory permit limits, incinerators still emit relatively large quantities of hazardous and criteria air pollutants. As noted in Chapter 1, these air pollutants contribute to and exacerbate cumulative impacts that exist in many environmental justice communities where the population is already overburdened and vulnerable. Furthermore, aging incinerators can experience accidents, malfunctions of their equipment, and declining maintenance, resulting in exceedances of their permitted pollution limits. This is particularly worrisome since studies show that environmental justice communities, where many incinerators are located, have underlying stressors that make them more susceptible to the detrimental health impacts of incinerator pollution.

Incineration Regulations and Public Health

MSW incinerators are relatively large emitters of air pollutants with some studies showing that they emit several pollutants at a rate exceeding that of fossil fuel power plants. Stack emissions include a variety of pollutants such as particulate matter (PM2.5, PM10, Ultrafine particles), nitrogen oxides (NOx), sulfur oxides (SOx), dioxins, nanoparticles, lead and mercury. Ash byproducts also contain dioxins and heavy metals like lead and mercury. Various factors impact the severity and spread of pollutants from a given MSW incinerator. These factors include the size and age of the incinerator, composition of the waste, emissions control technology, stack height and local weather conditions. For metals and other pollutants that are persistent in the environment, the potential effects may extend well beyond the area close to the incinerator and these toxins can build up in the human body over time.

> *"The unintended and uncontrolled release of toxic substances into the environment from waste incineration can occur because of malfunctioning equipment, large changes in the waste feed-stream, poor management of the incineration process, or inadequate maintenance or housekeeping. Off-normal operations (e.g., upsets and accidents) at various points in the incineration process might result in explosions; fires; the release of smoke, ash, or noxious odors into the atmosphere; and the spilling or leakage of contaminated or toxic substances."*[193]

The U.S. EPA regulates air pollutants with the expressed purpose to "protect public health and welfare." They do this primarily under the federal Clean Air Act (CAA) regulations with accompanying state laws. MSW incinerators are primarily regulated under Title V (CAA) permits typically issued by state environmental regulatory agencies. These permits establish atmospheric concentrations of six criteria pollutants that include carbon monoxide, lead, nitrogen oxides, ozone, particulate matter, and sulfur oxides. The CAA uses "MACT" or Maximum Achievable Control Technology standards to establish emissions requirements. The law also limits emissions of 187 hazardous air pollutants (HAPs).[194] Stationary sources like incinerators, which emit or have the potential to emit, ten or more tons per year of any one HAP or 25 tons per year or more of any combination of HAPs are regulated as a "major source" of air pollution and have to implement "maximum achievable control technology" ("MACT").[195]

The CAA does not require the U.S. EPA to eliminate health risks, but rather serves the purpose of reducing risk "sufficiently" to protect public health with an "adequate margin of safety."[196] This is an important consideration for environmental justice communities where a pattern of cumulative and disproportionate pollution exists and where the effects of multiple pollutants, from multiple sources and their synergistic and additive impacts are not well known or regulated.[197] Studies have demonstrated patterns of disproportionate, cumulative impacts in communities of color and low-income communities across the country.[198] These communities are known to experience adverse health outcomes related to socio-demographic characteristics, also known as social determinants of health. Some of the health burdens that have been documented in environmental justice communities include elevated blood lead levels, asthma, preterm births, and increased cardiovascular disease related morbidity and mortality rates.[199] These underlying health disparities combined with the cumulative impacts of multiple sources of pollution create a riskscape where incinerator emissions exacerbate environmental injustice.

Environmental justice communities' critique federal and state regulatory approaches that rely on permitting that only considers chemical by chemical and facility by facility assessments of environmental hazards. Regulations like the CAA and Title V permits for incinerators do not take into consideration

the multiple environmental and social stressors that contribute to the overall impact each facility has on health risks in the exposed population.[200] Another critique of the regulatory process for incinerators is related to emissions data and monitoring. Most of the criteria air pollutants and HAPs are self-reported to the U.S. EPA by facilities on an annual basis. Emissions estimates are typically derived from calculations based on operating conditions and confirmed via stack testing that occurs infrequently (1-5 years) and under "normal" operating conditions.[201] In limited cases, incinerators install Continuous Emissions Monitoring Systems (CEMS) for specific pollutants, such carbon monoxide, NOx, SOx, and opacity but CEMS are not in wide use by MSW facilities for pollutants such as dioxins, mercury or PM.[202]

The emissions reporting from incinerators may be underrepresenting the extent of emissions like dioxins or mercury because the release of these compounds is linked to the composition of the waste being burned at any one time and the assumption of optimal operating conditions which often are interrupted due to malfunctions in the equipment. Emissions measurements are also taken during "optimal operating" times and not during, for instance, start-up and shutdowns or operating upsets, when emissions are often at their highest.[203] Permit exceedances reported by incinerators are not always fined by state regulatory agencies due to relief granted to plants during periods of shut down, start up and malfunctions (SSM).[204] Some researchers and advocates believe emissions data pertaining to incinerators is underestimated or poorly characterized.[205]

Another critical consideration in assessing the health impacts of incinerators is the impact of poor operations and weak oversight and enforcement. In Chapter 2, anecdotal evidence suggests that incinerators in the U.S. have a pattern of accidents which can put local communities at risk. As these facilities age, the lack of proper enforcement coupled with increasing incidences can increase the emissions and related health risks from incinerators.

Environmental Justice and Incinerator Health Risks

Even if one assumes that the existing regulatory structures are sufficient to be protective of human health, environmental justice communities often do not receive the same levels of protection in terms of the enforcement and application of penalties for the violation of environmental laws.[206] Studies show that enforcement officials are slower to respond to incidences of violations and the fines have historically been set lower for facilities located in low-income and communities of color compared to those in whiter or wealthier communities. One study showed that penalties for pollution violations were 46 percent higher in white communities than communities of color.[207] This evidence of underestimating the potential health harm from the emissions of incinerators, the lack of attention to cumulative impacts assessment, the underlying social and health vulnerabilities of exposed populations, and the lax enforcement of existing laws, leads communities to justifiably worry that their health and well-being are not sufficiently protected when it comes to incinerators.

Existing Health Studies

The direct health impacts resulting from exposure to pollutants emanating from incinerators is not well understood or extensively studied in the epidemiological literature in the U.S. In the book, *Waste Incineration and Public Health* (2000), the authors note the reasons for this dearth of studies related to health and incinerators: relatively small study populations; emissions from other pollution sources; variations in human activity; and weaknesses in methodology and data sources.[208] Studies have shown that pollutants emitted from MSW combustion are known to be persistent, bio-accumulative and toxic and once dispersed into the environment these compounds can enter soil, water, and food systems.

> *"Incineration of chlorinated substances in waste, such as polyvinyl chloride (PVC) plastic, leads to the formation of new chlorinated chemicals, such as highly toxic dioxins, which are released in stack gases, ashes and other residues. In short, incinerators do not solve the problems of toxic materials present in wastes. In fact they simply convert these toxic materials to other forms, some of which may be more toxic than the original materials."*[209]

Source: United Workers.

Baltimore Incinerator Proposal Defeated

In 2009, Energy Answers International applied to construct the largest municipal solid waste incinerator in the United States in Curtis Bay, Maryland— a mile or less from Benjamin Franklin High School and Curtis Bay Elementary School. The Curtis Bay community suffered historically from disinvestment and the health impacts of polluting industries in their neighborhoods. These same neighborhoods have been ranked among the most polluted zip codes in the state and the country. In addition to existing polluting industries, the planned incinerator would have been permitted to emit 1,000 pounds of lead and 240 pounds of mercury annually. The company planned to spend nearly $1 billion on the plant which would burn 4,000 tons of waste per day, including plastic, rubber, auto parts and demolition debris.

Benjamin Franklin High School students began organizing when they were made aware of the plans for an incinerator in their community. Destiny Watford and her fellow students co-founded a group called "Free Your Voice" which planned to not only stop the largest incinerator in the U.S. from being constructed but advocated for long term neighborhood-driven development in Curtis Bay. The students went door-to-door informing other residents about the dangers of the incinerator project, held a march and led an act of civil disobedience, sending a message to the Maryland Department of Environment. When they learned that their own high school planned to buy energy from the incinerator, they gave a presentation at their school in opposition, effectively persuading the Baltimore City Public School system to end their proposed contract with the incinerator.[210] In time, 22 customers that planned to buy energy from the incinerator were persuaded to cancel their contracts, eliminating the financial viability of the project.[211]

Interestingly, Maryland is one of the few states in the U.S. that considers incineration a Tier 1 renewable energy source (on par with traditional renewables like wind and solar) in their Renewable Portfolio Standard. These energy subsidies, along with the potential to secure long-term public sanitation contracts with large institutions, allowed for the financing of this proposed facility. In 2016, the Maryland Department of Environment responded to the public pressure and determined that the Energy Answers International permit had expired, making it illegal for the company to construct the incinerator.[212] The defeat of this incinerator proposal in Baltimore reflects the importance of local, grassroots efforts to prevent the adoption of long term public contracts that finance these facilities and lock them into a polluting infrastructure.

After pollutants from an incineration facility disperse into the air, some people close to the facility may be exposed directly through inhalation or indirectly through consumption of food or water contaminated by deposition of the pollutants from air to soil, vegetation, and water.[213] In the European Union, MSW is the second most important emission source type for dioxins (iron ore sintering ranked highest).[214] Globally, waste disposal, primarily from incineration, contributes to ~8 percent of the total anthropogenic mercury emissions.[215] In a 2010 study of China's mercury source categories, emissions from incineration of municipal solid waste (MSW) was shown to experience the fastest growth due to the rapid expansion of the MSW incineration industry in China. According to this study "MSW incineration should be considered a high priority source in China's mercury control strategy."[216]

While the literature on the direct health impacts of waste incineration is limited in the U.S., there are a handful of studies from Asia and Europe in particular, where MSW incinerators are prevalent, that provide some insights into health-related impacts that can be applied in the U.S. context.[217] There are also case studies that point to specific health impacts such as a study that showed that dioxin emissions increase the risk of non-Hodgkin lymphoma among the population living in the vicinity of a municipal solid waste incinerator in France.[218] Another study in France considered all births (n = 21,517) of women residing within a 4-km radius of an incinerator at the time of delivery (2003-2010) and found that pre-term delivery increased with increased exposure.[219] A study in Italy analyzed the occurrence of miscarriages in women aged 15-49 years residing near seven incinerators of the Emilia-Romagna Region (Northern Italy, 2002-2006) and found that an increase of PM10, due to incinerator emissions was associated with an increased risk of miscarriage.[220] A 2005 study in Japan found that proximity of schools to municipal waste incineration plants may be associated with an increased prevalence of wheeze, headache, stomach ache, and fatigue in Japanese school children.[221] These health studies help shed light on the potential health risks posed by MSW incinerators in the U.S.

In order to characterize the nature of the potential health risk that aging incinerators in the U.S. might pose, several factors are summarized in this Chapter, including: (1) the health risks associated with specific air pollutants from incinerators, (2) a ranking of incinerators based on a snapshot of their emissions profiles for the most health harmful air pollutants and their presence in EJ communities, (3) a review of the coincidence of incinerator facilities in nonattainment areas, and (4) an estimation of emissions from waste hauling associated with incinerators.[222]

Incinerators as Major Sources of Air Pollutants

In 2017, the Environmental Integrity Project compiled a report, *The Truth is in the Trash*, comparing MSW incinerator emissions to coal-fired power plants and found that incinerators: produced, NOx, lead, and mercury at a higher rate than coal and Greenhouse Gases at an average rate that is 68 percent higher, per unit of energy delivered to the grid, than coal plants.[223] An example of the relative scale of pollution emitted by incinerators can be seen in the Montgomery County Resource Recovery Facility in Maryland. The plant releases approximately 740 tons of air pollutants annually and sends 180,000 tons of toxic ash to Virginia landfills.[224] The Environmental Integrity Project found that:

> *"On average between 2007 and 2009, the amount of mercury produced per hour of energy at MCRRF was 2-4 times and at WBI [Wheelabrator Baltimore Incinerator] 2.5-5.6 times that of the coal power plants. Between 2007 and 2009, MCRRF produced on average 3-8 times more lead per hour of energy than the coal power plants, while WBI produced on average between 6.5 and 18 times as much lead per hour. As with mercury, these emissions rates make WTE incinerators among the largest sources of lead in the state."*[225]

Table 6: Major Pollutants and their Sources

Pollutant	Examples of Sources
Dioxins	Plastics or fuels such as wood, coal and oil
Heavy metals	Batteries, pigments, leather, solder, cans, and consumer products and packaging
Chlorine	Polyvinyl chloride plastics and some bleached paper
Polystyrenes	Food service products such as rigid trays and containers and disposable eating utensils
Sulfur Oxides	Tires and gypsum wallboard
Nitrogen Oxides	Food and yard waste
Lead	Lead-acid car batteries, electronic items, leaded glass and plastics, batteries, fluorescent tubes, thermometers, and thermostats
PFOS, PFOA	Carpets, clothing, fabrics for furniture, paper packaging for food and other materials that are resistant to water, grease or stains

Some of the most health harmful pollutants emitted by incinerators include heavy metals like lead and mercury, as well as other hazardous air pollutants, particulate matter, nanoparticles, dioxins and furans.[226] Table 6 describes some of the primary sources of air pollutants emitted by incinerators. Because MSW incinerators burn a heterogenous mix of household and other waste, the resultant emissions from these facilities also varies significantly.

The combustion of household waste, plastics, fuel oil, electronic components or batteries for example, can emit dioxin. Dioxin emissions from incinerators have generated significant public health concerns because exposure, even in small amounts, can result in neurologic, immunologic, and reproductive impacts. According to the U.S. EPA, dioxins are "*are highly toxic and can cause cancer, reproductive and developmental problems, damage to the immune system and can interfere with hormones.*"[227] Dioxins are also extremely persistent compounds that take a long time to break down and can bioaccumulate. Studies show that "*epidemiologic data suggest that there is little or no margin of exposure for humans, [considered safe] with respect to these developmental effects.*"[228] Nanoparticles are another understudied but potentially harmful source of emissions from incineration of MSW. A 2014 study suggests that the fate of these particles, when incinerated is unclear, "*Due to the large variety of nanoproducts, the toxicity potential of nanomaterials and the wide range of potentially affected waste streams, the consequences for future waste management are currently unpredictable… The few available studies which address the incineration of nanoproducts have indicated that ENM [Engineered nanomaterials] removal efficiencies may vary significantly and depend on properties such as particle type and size.*"[229] Nanoparticles, ultrafine and PM2.5 particles can pose serious health risks to humans from the inhalation of these tiny particles.

> *"Epidemiological studies demonstrated associations between deaths and particulate air pollution even at extraordinarily low mass concentrations (Pope et al. 1992; Schwartz 1994) ….We pointed out that the majority of deaths associated with air pollution in the epidemiological studies were from cardiac rather than respiratory disease and attempted to explain the apparent fact that toxicologically tiny doses of particulate matter (PM), mainly carbon, to the lungs could cause death from failure of another organ."*[230]

A recent study concluded, "…. *anthropogenic $PM_{2.5}$ was responsible for 107,000 premature deaths in [U.S.] 2011, at a cost to society of $886 billion.*"[231]

There are a variety of health risks and uncertainties associated with the release of toxic air pollutants from incineration. The lack of conclusive scientific certainty relating to the causes and the consequences of the harm caused by certain substances or activities, however, should not be viewed as a reason to postpone preventative measures, as affirmed by many international conventions.[232] The precautionary principle was defined at the Wingspread Conference in 1998 as, "*When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically*".[233] This principle aims at ensuring a higher level of environmental protection through preventative decision-taking in the case of risk.[234] The precautionary principle tries to prevent harm before it occurs and is a foundational tenant of the Environmental Justice Movement. While the direct health implications of incineration are not well studied, incinerator emissions contribute to the overall cumu-

lative impacts that may harm EJ communities. Thus, the precautionary principle would lead communities to prefer less harmful alternatives to waste embodied in the approach of zero waste and waste reduction and diversion over incineration.

Danger on the Horizon: 2017 China Waste Ban

In 2017, China announced a ban on 24 types of solid waste, including certain plastics, unsorted scrap papers, and discarded textile materials. This ban sent shock waves through the waste management systems in the U.S., which are heavily reliant on the export of recyclables. Since the China Ban, municipalities are scrambling to find disposal options for their low quality, hard-to-recycle waste materials. In the short-run, many cities are sending recyclable materials to incinerators or landfills or letting them pile up.[235] If addressed properly, China's ban can activate additional investment in domestic recycling capacity, secondary material markets, and programs for reducing consumption.[236] Some of this plastic may end up in MSW incinerators. According to a Guardian article from February 2019, the Covanta incinerator in Chester, PA received a significant amount of Philadelphia's sorted recyclables in response to the ban from China. "*About 200 tons of recycling material is sent to the huge Covanta incinerator in Chester City, Pennsylvania, just outside Philadelphia, every day since China's import ban came into practice last year, the company says*."[237] In April 2019, Philadelphia announced that they would stop sending their recyclable material to the incinerator.[238] Increased plastic combustion is particularly worrisome because burning plastics releases toxic air pollution such as dioxins which increase the risk to host communities like Chester, Pennsylvania.[239]

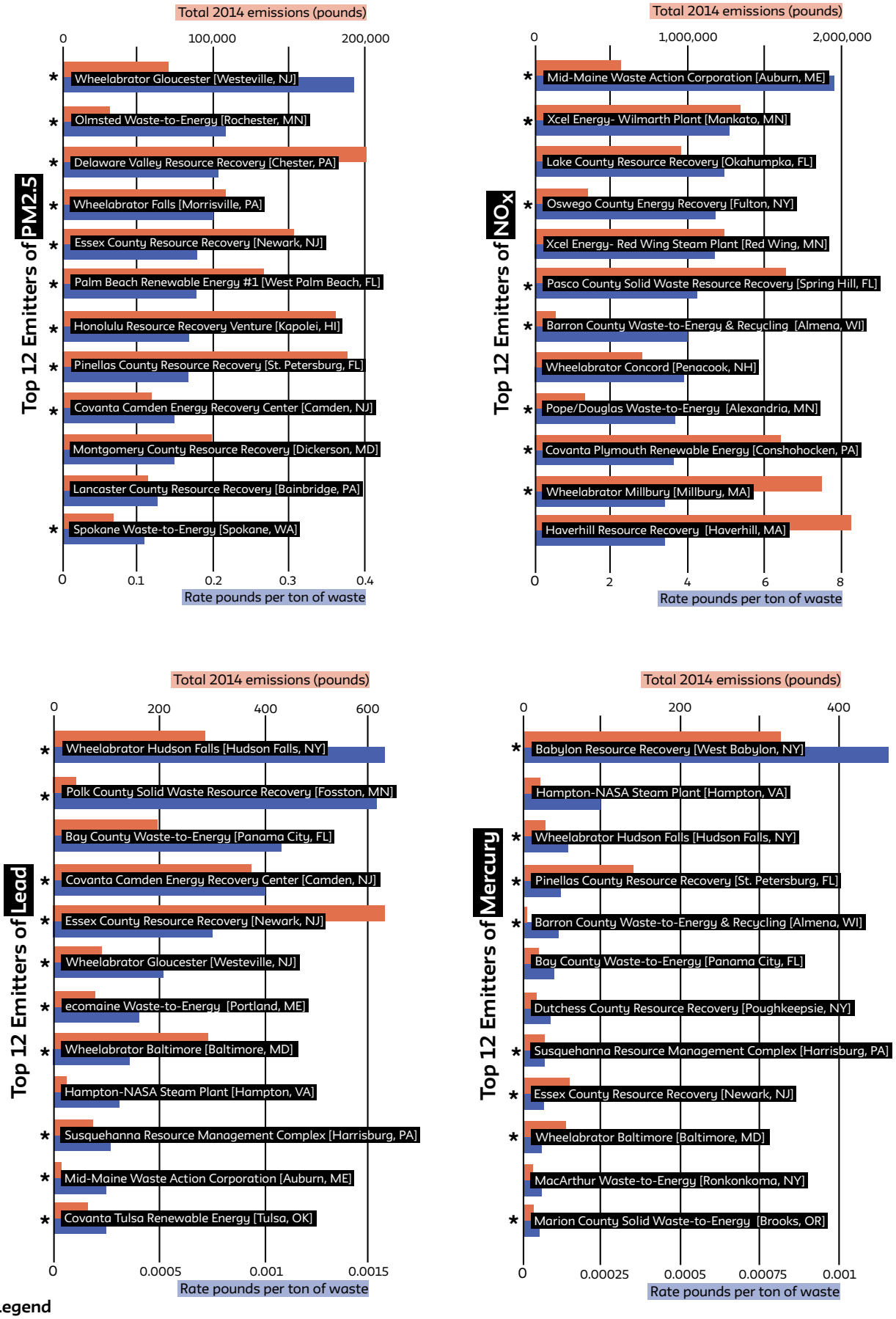
Incinerator Emissions Data: The Dirty Dozen

In order to assess the relative impact and health risks associated with MSW incinerators, a snapshot of air pollutant emissions data was compiled for all incinerators in 2014 (latest available data). Air pollution emissions data was obtained from the U.S. EPA's Enforcement and Compliance History (ECHO)[240] online database. ECHO provides facility-level compliance data for environmental regulations and Air Pollution Reports from the National Emissions Inventory,[241] Greenhouse Gas Reporting Program,[242] Toxic Release Inventory,[243] and Clean Air Markets Division.[244] Stack test data and emissions calculations are reported by the facility to state or tribal officials, who then report emissions to the EPA through the Emissions Inventory System (EIS). The EIS collect and publish this data every three years in the National Emissions Inventory online system that feeds into the ECHO website.

Emissions data for all 73 incinerators was collected for the following pollutants: NOx, SOx, mercury, lead, particulate matter (PM10 and PM2.5), and carbon monoxide. These pollutants represent some of the most health harming air pollutants emitted by incinerators, for which a complete dataset is available.[245] (See Appendix E for additional tables showing data for all seven pollutants). Facilities were ranked according to the top twelve highest emitters (among the 73 facilities nationwide) for each pollutant according to total annual emissions (lbs) and the rate of emissions (lbs/ton) per ton of waste incinerated. These top emitting facilities were then identified according to whether they are located in environmental justice communities (see Chapter 1 for definition of EJ communities). Figure 10 summarizes the results of this ranking exercise for particulate matter (PM 2.5), NOx, lead and mercury.

The "Dirty Dozen" Incinerators charts in Figure 10, illustrate the most polluting MSW incinerators according to PM2.5, NOx, Lead, and Mercury emissions. Approximately **1.6 million people** live within a three-mile radius of the "Dirty Dozen" incinerators for these four pollutants.[246] There are **4.4 million people** that live within a 3 mile radius of all 73 incinerators in the U.S. The relative emissions produced by an incinerator are in part dependent on the amounts of waste burned so that one would expect the largest incinerators to be most likely to emit the largest amount of pollutants. Since daily capacity to burn waste varies significantly among the 73 incinerators, it was important to examine both the total air pollutants (lbs) emitted annually as well as the rate of emissions (lbs/ton) per ton of waste combusted. The emissions rate was calculated by dividing the annual emissions (lbs) by the annual tons of waste burned at the facility. ***The Dirty Dozen charts reveal that most of the highest emitting facilities in each pollutant category (NOx, SO2, mercury, lead, PM 2.5, PM 10, CO), are in environmental justice communities.***

Figure 10: Dirty Dozen Incinerators



The following represents the number of "Dirty Dozen" incinerators that are located in EJ communities by pollutant category:

- PM10: 10
- PM2.5: 10
- Lead: 10
- NOx: 8
- SO2: 9
- CO: 8
- Mercury: 8

Ten of the twelve incinerators that emit the greatest amount of lead emissions, are in environmental justice communities. Exposure to lead can affect virtually every organ and can cause severe neurological damage in humans, especially in children and fetuses.[247] The Covanta owned, Essex County Resource Recovery incinerator in Newark, New Jersey emits the largest total amount of lead of any MSW incinerator in the country with over 600 pounds of lead reported in 2014, far above the next highest emitter, Covanta Camden (also in New Jersey) at 380 pounds. The Newark plant is emitting total annual lead levels higher than the largest incinerator facility in the U.S. These lead emissions are particularly troubling when considered in the context of the overall lead risk already present in the population. Children in Newark for example, represent 13 percent of the children in the state with elevated blood lead levels (Newark has 3.8 percent of the state's children).[248] The City of Newark is also experiencing widespread lead contamination in the City's drinking water supplies and more than thirty public schools tested above the federal action levels for lead in their drinking water.[249] The incinerator's lead emissions combine with multiple sources of lead in the home and school environments and may compound the potential health risks of already overburdened EJ communities in Newark. The Wheelabrator Hudson Falls incinerator in Washington County, New York is the highest per ton emitter of lead in the country and is also in an EJ community.[250]

Incinerators are also significant emitters of mercury. Mercury can cause neurologic, renal, developmental and reproductive damage.[251] Eight of the twelve incinerators with the highest emissions of mercury pollution in the U.S. are located in environmental justice communities. The Babylon Resource Recovery Facility in New York is located in an EJ community and it stands out as both the largest total emitter of mercury, releasing over 319 pounds of mercury annually as well as the highest per ton emitter in the country. The Pinellas County Resource Recovery Facility in St. Petersburg, Florida, emits 134.89 pounds of mercury annually and is also in an EJ community.

The incinerator that emits the most PM2.5 pollution in the country is the Delaware Valley Resource Recovery Facility in Pennsylvania, owned and operated by Covanta. In 2014, the facility emitted over 200,000 pounds of PM 2.5. This incinerator is in a non-attainment area for both PM2.5 (2012) and 8-hour Ozone (2015).[252] The PM emissions from the incinerator contributes to the overall air quality in the region and related health risks. PM2.5 is associated with decreased life expectancy and can cause or worsen several heart and lung problems.[253] Recent studies have shown that PM2.5 can have significant health and morbidity impacts on the US population.

> *"This translates to PM 2.5 causing an extra 20,000 deaths a year," said a co-author, Joel D. Schwartz, a professor of epidemiology at Harvard. "Separately, a 10 parts per billion decrease in ozone would save 10,000 lives per year. The effect was greater for low-income people, African-Americans, women and those over 70, and the risk remained significant even at levels below what the Environmental Protection Agency considers safe."*[254]

In 2012, Delaware County, PA had the highest pediatric inpatient hospitalization rate for asthma, after Philadelphia, in the state.[255] Even within the County, in 2013, Latino and Black children were more likely to have asthma than White children (2.5 and five times respectively).[256]

NOx (Nitrogen Oxides) is also a significant health impacting pollutant that is a major contributor to ozone, acid rain, and particulate matter.[257] NOx contributes to respiratory disease, cardiovascular disease and asthma.[258] The incinerators with the highest total annual emissions of NOx, are the I-95 Energy/Resource Recovery facility in Lorton, Virginia and the Pinellas County Resource Recovery Facility in St. Petersburg, Florida, both of which are located in EJ communities. Looking at the rate of NOx emissions per ton of waste burned, Mid-Maine Waste Action Corporation in Auburn, Maine and Xcel Energy-Wilmarth Plant in Mankato, Minnesota rank the highest, both are located in EJ communities.

Clean Air Act Violations

MSW incinerators are required, under the Clean Air Act, to have Title V operating permits that identify the amount of allowable emissions per year at a facility. If a facility exceeds the allowable emissions limits and operating parameters (i.e. temperatures, record keeping, monitoring, etc.) specified in the permit, these exceedances or violations of the permit are required to be reported to state regulatory authorities. The U.S. EPA collects and publicly reports enforcement and compliance information through a system called ECHO (Enforcement and Compliance History Online).[259] In order to assess the relative frequency and types of compliance issues occurring at incinerators across the country, a review of Clean Air Act violations data was compiled and assessed from the ECHO website. The ECHO website has known data gaps due to its reliance on a diverse range of inputs from various states. Each state tracks permit violations, enforcement actions and compliance differently, and each reports their information differently to the U.S. EPA. Thus, there are known gaps in the completeness and accuracy of this federal database.

The violations and compliance issues reported in ECHO are likely conservative estimates based on known case studies where state level data on permit violations and exceedances are much higher than what is reported in ECHO. For example, in January of 2019 the nonprofit groups Environment Michigan and the Ecology Center filed a Notice of Intent to Sue the Detroit incinerator alleging 600 violations of federal hourly limits on carbon monoxide and nitrogen oxide emissions over the past five years. According to the Detroit Free Press, the incinerator, "*exceeded pollution emissions standards more than 750 times over the last five years, Michigan Department of Environmental Quality records show.*"[260] In 2007, the Eastern Environmental Law Clinic filed a notice of intent to sue Covanta Energy, the owners of the Newark, NJ incinerator for noncompliance with the Clean Air Act, alleging hundreds of violations of federal clean air standards for sulfur dioxide, opacity, carbon monoxide and particulate matter.[261] These violations were likely not reported to the ECHO system, either because the state did not consider them violations or the state did not adequately report these exceedances into the federal database. Also, important to note is evidence that states have varying approaches to compliance and enforcement, with some states adopting more aggressive inspection and enforcement oversight than others.[262]

ECHO data for the 73 incinerators reveals that an estimated 21 incinerators received 126 "Federally Reportable Violations" under the Clean Air Act between 2016 – 2019.[263] Data were pulled from the Three-Year Compliance History table from each facility's page on ECHO as well as facility fines (fines levied by state agencies). Twenty-one incinerators received 49 fines totaling $535,737. Table 7 summarizes the incinerators with the greatest number of violations logged in ECHO between 2016 and 2019.

Incinerators may receive violations for exceeding emissions limits under their Title V permits for one or more pollutants, or for "facility or administrative issues." These administrative issues may refer to poor record keeping or monitoring practices, failure to submit or file reports with the state, or to maintain operational parameters required in the permit such as specific temperature controls, feed rates or oxygen levels.[264] Pollutants that appear the most often as violations include carbon monoxide, sulfur dioxide, and particulate matter. These violations may be the result of incomplete combustion, equipment malfunction or other compromised conditions within the facility. Interestingly, many of the same pollutants that are typically monitored via Continuous Emissions Monitoring Systems (CEMS) like carbon monoxide, also appear frequently in the list of compliance issues (stack-gas concentrations of O_2, CO, NO_x, SO_x, and opacity are often monitored via CEMs).

This points to another potential limitation in the oversight of incinerators - without CEMS for pollutants of greatest health concern like dioxins, mercury, and lead - facilities may be underreporting the instances of exceedances occurring at incinerators. CEMS for these pollutants is not currently required for most existing MSW incinerators in the U.S. "*Reliable continuous emission monitors (CEMs) for dioxins and furans or for metals would be desirable, because automatic devices electronically linked to such devices could directly control those emissions of greatest potential health consequence.*"[265] The Baltimore City Council recently passed a bill to require incinerator facilities to install CEMS for many of these pollutants as well as institute more stringent emissions limits.[266] This bill may result in the closure of the Baltimore incinerator due to the costs to retrofit the plant,

Table 7: MSW Incinerator Violators and Fines Levied (2016-2019)

Top MSW Violators and Fines Levied (2016-2019)					
	MSW Incinerator	State	# of Violations	# of fines (amount of fine $)	Example of recent Violations
1	Covanta Plymouth Renewable Energy	PA	33	8 ($73,045)	Administrative
2	Detroit Renewable Power*	MI	27	1 ($149,000)	Sustained High Priority Violations for every quarter between April 2016 and March 2019 when it closed. Sulfur Dioxide, Carbon Monoxide.
3	Delaware Valley Resource Recovery	PA	11	4 ($34,217)	Administrative
4	Lancaster County Resource Recovery	PA	8	1 ($42,196)	Administrative
5	York County Resource Recovery	PA	8	1 ($9,148)	Administrative
6	Covanta Camden Energy Recovery Center	NJ	5	4 ($7,050)	Particulate Matter, Sulfur Dioxide, Carbon Monoxide
7	Perham Resource Recovery	MN	5	1 ($11,370)	Cadmium, Particulate Matter, Administrative
8	Essex County Resource Recovery	NJ	3	6 ($90,960)	Particulate Matter, Sulfur Dioxide, Carbon Monoxide
9	Covanta Tulsa Renewable Energy	OK	3	0	Unresolved continuous Carbon Monoxide since 2014
10	Wheelabrator Portsmouth	VA	2	1 ($7,669)	Chlorinated Dioxin and Furans
11	Xcel Energy French Island Generating Station	WI	2	0	Total Hazardous Air Pollutants
12	Wheelabrator Bridgeport	CT	1	0	Unresolved continues Mercury emissions
*Closed in March 2019					

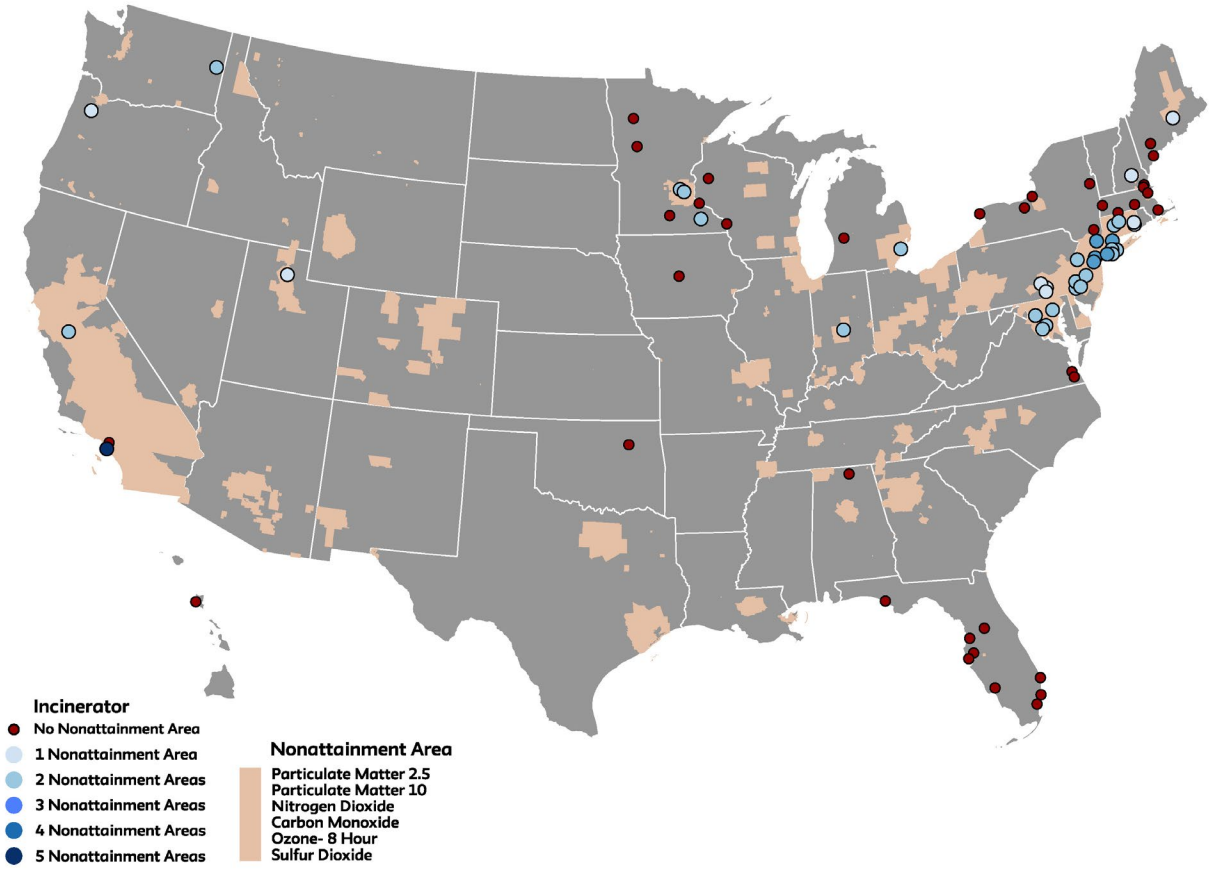
"*The incinerators' owners say it would be impossible to retrofit their plants to meet the standards set out in the legislation and so would have to close if the strict standards go into effect.*"[267] The added risk from poorly functioning and non-compliant facilities exacerbates existing health risks.

Incinerators and Areas Out of Attainment with the National Ambient Air Quality Standards (NAAQS)

The National Ambient Air Quality Standards (NAAQS) sets national limits for the six criteria pollutants based on atmospheric (ambient) concentrations. Areas of the country are assessed for these six pollutants: ground level ozone, particulate matter (PM), lead, sulfur dioxide (SOx) and nitrogen dioxide (NOx) and carbon monoxide. If an area is determined to be "not in attainment" for any of the criteria pollutants, states are expected to develop a State Implementation Plan (SIP) for achieving attainment through state-selected and enforced controls on emissions.

In order to assess the underlying air quality conditions in the places where incinerators are located, the Nonattainment Areas for Criteria Pollutants Green Book (2019) was used to generate a map showing the location of MSW incinerators within nonattainment areas (all nonattainment areas for all six criteria pollutants combined). There are 39 incinerators that fall within a nonattainment area for one or more criteria pollutants. Twenty-two incinerators fall within two nonattainment areas and five incinerators fall within three nonattainment areas. The Southeast Resource Recovery Facility in Long Beach, California is the only facility that falls within five nonattainment areas. Figure 11 depicts the incinerators located in non-attainment areas in the shaded areas on the map.

Figure 11: MSW Incinerators in Non-Attainment Areas



The presence of incinerators in areas that are in non-attainment for criteria air pollutants indicates places where the industry is contributing to already poor air quality. A recent study has shown that there are significant gaps in air pollution monitors used to designate nonattainment areas and therefore the scope of the problem may be underestimated. Using satellite data, this study found that 47.6 million Americans (up from 23.3 million) live in counties that do not meet that standard for PM2.5.[268] Many of these communities are burdened with pollution from multiple sources impacting public health and well-being, including MSW incinerators.

Diesel Emissions from Waste Hauling to Incinerators

In addition to stationary source air pollution, waste incineration impacts environmental and human health via mobile source emissions derived from the largely, heavy-duty diesel (HDD) sanitation trucks that collect and haul almost all MSW in the country and concentrate near MSW facilities.

> *"Garbage trucks are one of the least efficient vehicles on the road. Powered by diesel fuel, they average just 3 miles per gallon, burn about $42,000 of fuel per year, and emit about 20 times the carbon emissions of the average US home. As they rumble down city streets waking residents at dawn, they make more than 1,000 stops a day and log an average of 130 miles a day."*[269]

Sanitation trucks release significant health harming diesel particulates including black carbon and soot as well as nitrogen oxides, particulate matter, carbon monoxide, and volatile organic compounds.[270] One of the most direct and localized sources of air pollution associated with proximity to MSW incinerators are diesel emissions from sanitation trucks. Since MSW incinerators operate 24 hours a day, seven days a week, the impact of these diesel trucks on local communities can be significant. Many of these communities have multiple waste facilities, such as transfer stations, and may see thousands of diesel trucks per day from a variety of sources. Waste delivered to incinerators may originate from more affluent neighborhoods or even different states and spend time queuing at the incinerator or traveling into the

facility via residential streets. Living near a waste site may mean chronic exposure to diesel fumes which have been classified as a carcinogen by the National Cancer Institute[271] and may contain up to 40 types of hazardous air pollutants.[272]

Diesel trucks have the worst fuel economy of highway vehicles[273] and emit approximately 20 percent of global anthropogenic emissions of nitrogen oxides (NO_x), which are key PM2.5 and ozone precursors.[274] Rear-loader refuse trucks are most common for collecting residential trash and have an average fuel economy of between 1 and 3 miles per gallon.[275] Table 8 summarizes the pounds of pollutants (VOCs, carbon monoxide, nitrogen oxides, and particulate matter 2.5 and 10) emitted per day by these trucks.[276] These calculations on based on estimates of the average refuse truck which travels an estimated 130 miles per day and 25,000 miles per year.[277] Sanitation trucks consume 43-130 gallons of diesel fuel daily, based on an average fuel economy.

The average incinerator handling 1,300 tons/day requires a sanitation truck fleet of approximately 186 diesel trucks per day. According to the estimates of emissions in Table 9, a fleet of this size would emit (annually) approximately:

- 8,760 lbs of volatile organic compounds
- 33, 215 lbs of carbon monoxide
- 142,715 lbs of nitrogen oxides
- 3,285 lbs of PM 2.5

The Miami-Dade County Resource Recovery Facility is the largest MSW incinerator in the country (4,200 tons/day) and its truck fleet would require double or triple the amount of trucks required of the average incinerator. Based on the total amount of tons hauled in a year and the tonnage an average sanitation truck can haul, Miami-Dade County Resource Recovery Facility's truck fleet was estimated to be between 672 and 840 diesel trucks daily. The total emissions from a fleet of 672 trucks (each 35 cubic yards in size hauling 7 tons of waste) would emit (annually):

- 31,755 lbs of volatile organic compounds
- 120,085 lbs of carbon monoxide
- 515,015 lbs of nitrogen oxides
- 12,410 lbs of PM 2.5

The resultant emissions contribute to the health burden and risk in host communities, particularly for communities that face the cumulative exposure to multiple mobile and stationary sources of pollution. These emissions are not factored into the regulatory permits or emissions thresholds for incinerators. Thus, the full extent of their impact on local health is underestimated by regulatory agencies.

Table 8: Pollutants Released by Heavy Duty Diesel Sanitation Trucks

Heavy Duty VII Diesel-Burning Refuse Trucks (130 miles/day)			
Pollutants	**One Truck** (lbs/day)	**Fleet of 119 Trucks** (lbs/day)	**Fleet of 181-265 trucks** (lbs/day)
Volatile Organic Compounds	0.13	15.43	23.48 - 34.37
Carbon Monoxide	0.49	58.31	88.69 - 129.85
Nitrogen Oxide	2.1	249.90	380.1 - 556.5
Particulate Matter 2.5	0.05	5.95	9.05 - 13.25
Particulate Matter 10	0.05	5.95	9.05 - 13.25

Conclusion

MSW incinerators in the U.S. are aging facilities that face an increasingly uncertain economic future. This industry benefits from a lax regulatory system and government support in a variety of forms from direct public expenditures to renewable energy subsidies. Incinerators represent an affront to environmental justice communities by contributing to disproportionate, cumulative impacts in communities of color and low-income communities. These communities are host to a majority of the incinerators in the country which emit large amounts of health harming air pollution. Two multinational corporations, Covanta and Wheelabrator, dominate the incinerator industry, relying on large public sanitation contracts and energy subsidies to remain profitable. However, incinerators face increasing scrutiny and community opposition as cities and states advance zero waste alternatives to incineration. More than thirty plants have closed in the last twenty years largely due to economic conditions like the loss of waste volume. The incineration industry must also deal with tight competition for tipping fees, and tight profit margins that are vulnerable to abrupt changes in waste or electricity markets. Additionally, these facilities are experiencing rising operation and maintenance costs as they reach the end of their 30-year life expectancy.

Incinerators emit significant amounts of air pollutants that can contribute to overall environmental and public health risks. Despite the existence of environmental regulations, state and federal regulatory agencies tasked with protecting human health are not doing enough to monitor and regulate this industry. Some of the largest emitters of air pollutants among the MSW incinerators in the U.S. are located in EJ communities. Finally, the relationship between incinerators and environmental justice communities reveals the disproportionate impact that this industry has on the most overburdened areas of the country who contribute the least, proportionately, to the waste problem. In the last year alone, two more incinerators were shuttered, in Detroit and Commerce. These facility closures reflect the power of environmental justice communities to advance the case against incineration and the impending decline of MSW incinerators in the U.S.

Endnotes

1 At this report was written, Detroit Renewable Power announced imminent closure of one of the dirtiest MSW incinerators in the country built in an environmental justice community in 1989. This report will refer to 73 MSW incinerators, acknowledging that there are now 72 incinerators left. Detroit Renewable Power cited lack of sufficient funds as their reason for closure.

2 For more information on recent closures, please refer to the end of Chapter 2.

3 Environmental justice communities are commonly identified as those where residents are predominantly minorities or low-income; where residents have been excluded from the environmental policy setting or decision-making process; where they are subject to a disproportionate impact from one or more environmental hazards; and where residents experience disparate implementation of environmental regulations, requirements, practices and activities in their communities. (California Energy Commission, "Environmental Justice," Accessed April 9, 2019).

4 Covanta, *2018 Annual Report,* (Morristown, NJ: Covanta, 2019).

5 Covanta, *2018 Annual Report,* 58.

6 To estimate average age of all MSW incinerators in the U.S., the year of construction for each incinerator was found through an online search of various public records including websites for operating companies such as Covanta, Wheelabrator, and Xcel Energy.

7 Global Alliance for Incinerator Alternatives, *Incinerators in Trouble,* (Global Alliance for Incinerator Alternatives, 2018).

8 Wheelabrator Baltimore, L.P., v. Baltimore County, Maryland. Complaint and Demand for Jury Trial in the Court for Baltimore County, Maryland, April 11, 2019.

9 Romy Varghese, Michael Bathon, and Linda Sandler, "Harrisburg Files for Bankripcy on Overdue Incinerator Debt," *Bloomberg,* October 12, 2011.

10 Barbara Warren et al., *Burning Public Money for Dirty Energy,* (Berkley, California: Global Alliance for Incinerator Alternatives, 2011).

11 For more information on the comparison in energy generation costs, please see GAIA's *Burning Public Money for Dirty Energy* report, published November 2011.

12 Warren, et al. *Burning Public Money for Dirty Energy.*

13 Steven C. Russo et al., *Comments of the New York State Department of Environmental Conservation Regarding the Verified Petition of Covanta Energy Corporation,* (Albany, New York: New York State Department of Environmental Conservation, 2011.

14 N. Pirrone et al., "Global Mercury Emissions to the Atmosphere from Anthropogenic and Natural Sources," *Atmos. Chem. Phys. Discuss.* 10, no. 2 (2010): 4719–4752.

15 Based on demographic data from the U.S. EPA's ECHO data, approximately 1.6 million people live within a three-mile radius of the facilities listed in the Dirty Dozen tables for four of the most harmful pollutants to human health; NOx, Lead, PM2.5, and Mercury.

16 During completion of this report (March 2019), Detroit Renewable Power announced imminent closure of one of the dirtiest MSW incinerators in the country built in an environmental justice community in 1989. This report will refer to 73 MSW incinerators, acknowledging that there are now 72 incinerators left. Detroit Renewable Power cited lack of sufficient funds as their reason for closure.

17 U.S. Environmental Protection Agency, "National Overview: Facts and Figures on Materials, Wastes and Recycling," Accessed March 12, 2019: Ted Michaels and Ida Shiang, *Energy Recovery Council 2016 Directory of Waste-to-Energy Facilities,* (Washington D.C.: Energy Recovery Council, 2016).

18 For more information on recent closures, please refer to the end of Chapter 3.

19 Marie Donahue, Waste Incineration: *A Dirty Secret in How States Define Renewable Energy*, Washington, D.C.: Institute for Local Self-Reliance, 2018. Global Alliance for Incinerator Alternatives, *Incinerators in Trouble*: Donahue, *Waste Incineration: A Dirty Secret in How States Define Renewable Energy*.

20 Ana I. Baptista and Kumar Amarnath, "Garbage, Power, and Environmental Justice: The Clean Power Plan Rule," *William & Mary Environmental Law & Policy Review* 41, no. 2 (2016): 403-433.

21 U.S. Energy Information Administration, *What is U.S. Electricity Generation by Energy Source?,* (Washington, D.C.: U.S. Energy Information Administration, 2018).

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to the extent that the facility latitude and longitude listed are correct. According to ECHO: "the radius is measured from the best available latitude/longitude coordinate of the facility or permit holder. Surrounding populations and other statistics were estimated by retrieving the data for Census block groups within the requested radius from each facility." "People of color" is determined by the percentage of the population of the given area that has self-identified as being a minority. The field is calculated by subtracting the number of persons who are "White" (and white-Hispanic) from the total persons. This number is then divided by the total persons and multiplied by one hundred to determine the percentage. The "Percentage of those experiencing poverty" is determined by taking the total "Persons Below [federal] Poverty Level", dividing it by the total persons, and then multiplying it by 100. and subtracting the number of total persons. This number is then divided by total persons and multiplied by one hundred to determine the percentage. According the US Census Bureau, "Poverty Level" is determined by "Poverty Thresholds": A poverty threshold is a specified dollar amount considered to be the minimum level of resources necessary to meet the basic needs of a family unit. Thresholds vary by the number and age of adults and the number of children under age 18 in the family unit, but they are the same for all states. If a family's annual before-tax income is less than the threshold for their family size and type, all individuals in the family are considered as "Below the poverty level."

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242 Greenhouse Gas Reporting Program: Beginning in 2009, the U.S. EPA required reporting of greenhouse gases (GHG) from sources that in general emit 25,000 metric tons or more of carbon dioxide equivalent per year in the U.S. The GHG Reporting Program collects Greenhouse Gas data from large emitting facilities, suppliers of fossil fuels and industrial gases that result in GHG emissions when used, and facilities that inject carbon dioxide underground.

243 Toxic Release Inventory: U.S. EPA's Toxic Release Inventory requires U.S. facilities in different industry sectors to report annually how much of each chemical is released to the environment and/or managed through recycling, energy recovery and treatment. TRI is meant to inform the public about information

around chemical releases.

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Agencies use the FRV Determination Date and the Resolved Date to display an FRV date range in ECHO. These include Alabama, Florida, Massachusetts, and North Carolina.

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four major roadway types, the national average values for registration distributions by model and year, among other considerations. U.S. EPA's 2008 MOBILE6.2 computer program which gave us the number of / grams released per mile for refuse trucks. There are approximately 454 grams in a pound. The conversion, from mass pollutant emitted per unit work to mass pollutant emitted per unit distance traveled was performed using "conversion factors" that express the average amount of work required to move a given heavy-duty truck over one mile (brake horsepower-hour per mile, or bhp-hr/mi). (Environmental Protection Agency- Office of Transportation and Air Quality. 2008. "Average In-Use Emissions from Heavy-Duty Trucks." EPA420-F-8–27.) The number of refuse trucks on the road daily for each MSW incinerator was estimated based upon the waste tonnage capacity per day for each incinerator and then roughly how many truck trips it would take to transport that amount of waste. For tonnage capacity, we gathered data from the Energy Recovery Council Directory 2016 and Covanta and Wheelabrator facility profiles. We divided tonnage capacity for each incinerator by the weight of trash capacity in tons (7) the average rear loader refuse truck can hold. We assume a range between 7 and 11-ton capacity for each truck. For diesel trucks per incinerator we divided the tonnage per day for each incinerator by 7 and 11 to get a range depending on the capacity of the truck.

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APPENDIX A: List of 73 MSW Incinerators in the U.S.

***Red highlight indicates incinerators located in an Environmental Justice community.**

Name	City, State	Operator	Initial Operation Year
Alexandria/Arlington Resource Recovery	Alexandria, VA	Covanta	1988
Arnold O. Chantland Resource Recovery Plant	Ames, IA	City of Ames	1975
Babylon Resource Recovery	West Babylon, NY	Covanta	1989
Barron County Waste-to-Energy & Recycling	Almena, WI	ZAC Inc	1986
Bay County Waste-to-Energy Facility	Panama City, FL	Engen	1987
Bristol Resource Recovery Facility	Bristol, CT	Covanta	1988
Connecticut Solid Waste System Resource Recovery	Hartford, CT	NAES Corporation	1987
Covanta Camden Energy Recovery Center	Camden, NJ	Covanta	1991
Covanta Hempstead	Westbury, NY	Covanta	1989
Covanta Plymouth Renewable Energy	Conshohocken, PA	Covanta	1982
Covanta Tulsa Renewable Energy	Tulsa, OK	Covanta	1986
Delaware Valley Resource Recovery	Chester, PA	Covanta	1992
Detroit Renewable Power	Detroit, MI	Detroit Renewable Energy	1989
Dutchess County Resource Recovery	Poughkeepsie, NY	Wheelabrator	1987
Ecomaine Waste-to-Energy	Portland, ME	ecomaine	1988
Essex County Resource Recovery	Newark, NJ	Covanta	1990
Hampton-NASA Steam Plant	Hampton, VA	City of Hampton	1980
Haverhill Resource Recovery	Haverhill, MA	Covanta	1989
Hennepin Energy Resource Center	Minneapolis, MN	Covanta	1989
Hillsborough County Resource Recovery	Tampa, FL	Covanta	1987
Honolulu Resource Recovery Venture	Kapolei, HI	Covanta	1990
Huntington Resource Recovery	East Northport, NY	Covanta	1991
Huntsville Waste-Energy	Huntsville, AL	Covanta	1990
I-95 Energy/Resource Recovery	Lorton, VA	Covanta	1990
Indianapolis Resource Recovery	Indianapolis, IN	Covanta	1988
Kent County Waste-to-Energy	Grand Rapids, MI	Covanta	1990
Lake County Resource Recovery	Okahumpka, FL	Covanta	1991
Lancaster County Resource Recovery	Bainbridge, PA	Covanta	1991
Lee County Resource Recovery	Fort Myers, FL	Covanta	1994
MacArthur Waste-to-Energy	Ronkonkoma, NY	Covanta	1990
Marion County Solid Waste-to-Energy	Brooks, OR	Covanta	1987
McKay Bay Refuse-to-Energy	Tampa, FL	Wheelabrator	1985
Miami-Dade County Resource Recovery	Doral, FL	Covanta	1982
Mid-Maine Waste Action Corporation	Auburn, ME	Mid-Maine Waste Action Corp	1992
Montgomery County Resource Recovery	Dickerson, MD	Covanta	1995
Niagara Falls Resource Recovery	Niagara Falls, NY	Covanta	1980
Olmsted Waste-to-Energy	Rochester, MN	Olmsted County	1987
Onondaga Resource Recovery	Jamesville, NY	Covanta	1995
Oswego County Energy Recovery	Fulton, NY	Oswego County	1986
Palm Beach Renewable Energy #1	West Palm Beach, FL	Covanta	1989
Palm Beach Renewable Energy #2	West Palm Beach, FL	Covanta	2015
Pasco County Solid Waste Resource Recovery	Spring Hill, FL	Covanta	1991

APPENDIX A: Continued

Name	City, State	Operator	Initial Operation Year
Penobscot Energy Recovery Company	Orrington, ME	ESOCO	1988
Perham Resource Recovery	Perham, MN	Prarie Lakes Municipal Solid Waste Authority	1986
Pinellas County Resource Recovery	St. Petersburg, FL	Covanta	1983
Pioneer Valley Resource Recovery	Agawam, MA	Covanta	1988
Pittsfield Resource Recovery	Pittsfield, MA	Covanta	1981
Polk County Solid Waste Resource Recovery	Fosston, MN	Polk County	1988
Pope/Douglas Waste-to-Energy	Alexandria, MN	Pope/Douglas Solid Waste Joint Powers Board	1987
SEMASS Resource Recovery	West Wareham, MA	Covanta	1988
Southeast Resource Recovery	Long Beach, CA	Covanta	1988
Southeastern Connecticut Resource Recovery	Preston, CT	Covanta	1991
Spokane Waste-to-Energy	Spokane, WA	City of Spokane	1991
Stanislaus County Resource Recovery	Crows Landing, CA	Covanta	1989
Susquehanna Resource Management Complex	Harrisburg, PA	Covanta	1972
Union County Resource Recovery	Rahway, NJ	Covanta	1994
Wheelabrator Baltimore	Baltimore, MD	Wheelabrator	1985
Wheelabrator Bridgeport	Bridgeport, CT	Wheelabrator	1988
Wheelabrator Concord	Penacook, NH	Wheelabrator	1989
Wheelabrator Falls	Morrisville, PA	Wheelabrator	1994
Wheelabrator Gloucester Company	Westeville, NJ	Wheelabrator	1990
Wheelabrator Hudson Falls	Hudson Falls, NY	Wheelabrator	1991
Wheelabrator Lisbon	Lisbon, CT	Wheelabrator	1995
Wheelabrator Millbury	Millbury, MA	Wheelabrator	1987
Wheelabrator North Andover	North Andover, MA	Wheelabrator	1985
Wheelabrator Portsmouth	Portsmouth, VA	Wheelabrator	1988
Wheelabrator Saugus	Saug, MA	Wheelabrator	1975
Wheelabrator South Broward Inc.	Fort Lauderdale, FL	Wheelabrator	1991
Wheelabrator Westchester	Peekskill, NY	Wheelabrator	1984
Xcel Energy French Island Generating Station	La Crosse, WI	Xcel Energy	1988
Xcel Energy- Red Wing Steam Plant	Red Wing, MN	Xcel Energy	1987
Xcel Energy- Wilmarth Plant	Mankato, MN	Xcel Energy	1987
York County Resource Recovery Center	York, PA	Covanta	1989

APPENDIX B: Cost Calculations for Average Annual Operation & Maintenance Costs for MSW Incinerators

SOURCE	CALCULATION	ESTIMATE OF O &M (ANNUAL $)
World Bank estimates for median size incinerator based on tonnage & fees	• Median size MSW incinerator = 1,050 tons of waste/day • World Bank average annual operating costs for an incinerator = $44 to $55 per ton of waste • 1,050 ton-per-day facility costs ~$17 million to $21 million annually to operate • Calculation: 1,050 tons per day of waste X $44 or $55/ton X 365 days	(1,050 tons/day x 365 days x $44-$55/ton) = **$17 million - $21 million**
U.S. EIA estimates of waste burning costs per kilowatt-year	• Waste burning costs (2013 estimate) $392.82 per kilowatt-year in fixed operating & maintenance cost. • Median gross capacity of electricity production of MSW incinerators = 61 MW • $392.82 MW-year X 61 MW ~ roughly $24 million in operation costs per year	$392,820 X 61 MW = **$24 million**
York County Resource Recovery Facility	• 1,344 tons/year capacity • $62/ton = Tipping fee • 42 MW/year = electricity sales • O & M reported = $20,440,360	Publicly available financial records **$20,440,360**

APPENDIX C: Incinerator Tip Fee Sources

State	Incinerators	Tip Fee	Source of Tip Fees
AL	Huntsville Waste-Energy	$40.00	Ulloa et al, [report], 2019
CA	Stanislaus County Resource Recovery	$39.00	Government Technology, [article], 2015
	Southeast Resource Recovery	$80.00	City of Long Beach, CA, [article], 2018
CT	Wheelabrator Lisbon	$65.00 - $75.00	Town of Lisbon, CT, [report], 2011
	Wheelabrator Bridgeport	$60.00	City of Bridgeport, CT, [report], 2018
	CT Solid Waste System Resource Recovery	$72.00	Hartford Courant, [article], 2018
FL	Wheelabrator South Broward Inc.	$64.21	Golden Beach, FL, [document], 2019
	Pinellas County Resource Recovery	$37.50	Pinellas County, FL, [website], 2019
	Pasco County Solid Waste Resource Recovery	$59.30	Lee County, FL, [report], 2018
	Palm Beach Renewable Energy #1	$42.00	Lee County, FL, [report], 2018
	Palm Beach Renewable Energy #2	$42.00	Lee County, FL, [report], 2018
	McKay Bay Refuse-to-Energy	$71.00	City of Tampa, FL, [document], 2019
	Lee County Resource Recovery	$50.20 - $67.45	Lee County, FL, [report], 2018
	Miami-Dade County Resource Recovery	$62.67	Miami-Dade County, FL, [website], 2019
	Hillsborough County Resource Recovery	$69.40	Lee County, FL, [document], 2018
HI	Honolulu Resource Recovery Venture	$45.00	City and County of Honolulu, [report], 2016
IA	Arnold O. Chantland Resource Recovery Plant	$55.00	City of Ames, IA, [report], 2016
IN	N/A	N/A	N/A
MA	Wheelabrator North Andover	$69.54	Town of Waterton, MA, [document], 2014
	Wheelabrator Millbury	$67.99	Town of Northborough, MA, [report], 2017
	SEMASS Resource Recovery	$78.37	The Patriot Ledger, [article], 2018
	Haverhill Resource Recovery	$58.00	Town of Bedford, MA, [website], 2018
MD	Wheelabrator Baltimore	$50.00	Inst. for Local Self-Reliance, [report], 2017
	Montgomery County Resource Recovery	$60.00	Montgomery County, MA, [document], 2018
ME	Penobscot Energy Recovery Company	$81.50	CommonWealth, [document], 2018
	Mid-Maine Waste Action Corporation	$82.00	Sun Journal, [article], 2018
	ecomaine Waste-to-Energy	$73.00	Sun Journal, [article], 2018
MI	Kent County Waste-to-Energy	$55.00	Michigan Live, [report], 2017
	Detroit Renewable Power	$15.00- $25.00	Great Lakes Enviro. Law Ctr, [report], 2018
MN	Perham Resource Recovery	$80.00	Minn. Pollution Control Age., [report], 2012
	Pope/Douglas Waste-to-Energy	$98.00	Echo Press, [article], 2018

APPENDIX C: Continued

State	Incinerators	Tip Fee	Source of Tip Fees
	Olmsted Waste-to-Energy	$83.00-$108.31	Governmental Advisory Assoc. [report], 2012
	Hennepin Energy Resource Center	$85.00	Hennepin County, MN, [report], 2019
NH	Wheelabrator Concord	$64.00	Concord Monitor, [article], 2013
NJ	Wheelabrator Gloucester	$83.50	Town of Rockport, MA, [report], 2019
	Union County Resource Recovery	$107.00	Union Co. Utilities Authority, [website], 2018
	Essex County Resource Recovery	$130.55	Atlantic Co. Utilities Authority, [website], 2018
	Covanta Camden Energy Recovery Center	$68.68	Town of Berlin, New Jersey, [document], 2018
NY	Wheelabrator Westchester	$75.95	USA Today, [article], 2014
	Wheelabrator Hudson Falls	$62.00	Hamilton County, NY, [report], 2012
	Oswego County Energy Recovery	$75.00	Oswego County, [document], 2018
	Onondaga Resource Recovery	$95.00	Syracuse, [article], 2018
	Dutchess County Resource Recovery	$76.15	Dutchess County, NY, [report], 2017
OK	N/A	N/A	N/A
OR	N/A	N/A	N/A
PA	Delaware Valley Resource Recovery	$63.00	City of Philadelphia, [report], 2018
	Susquehanna Resource Management Complex	$85.00	Press & Journal, [article] 2016
	York County Resource Recovery Center	$62.00	YC Solid Waste Authority, [website] 2019
	Lancaster County Resource Recovery	$62.00	SWANA, [report], 2012
	Covanta Plymouth Renewable Energy	$59.76	The Inquirer, [article], 2019
VA	Wheelabrator Portsmouth	$62.00	The Virginia- Pilot, [article] 2018
	I-95 Energy/Resource Recovery	$66.00	Fairfax County, [report], 2018
	Alexandria/Arlington Resource Recovery	$49.42	City of Alexandria, VA, [report], 2012
WA	Spokane Waste-to-Energy	$107.53	City of Spokane, [website], 2019
WI	Xcel Energy French Island Generating Station	$62.00	La Crosse Solid Waste Dpt, [website], 2019

APPENDIX D: Pollutants and Related Health Impacts

Pollutant	Short Term Health Impacts	Long Term Health Impacts and High Exposure
Nitrogen Oxides (NOx)	Aggravates asthma, leading to respiratory symptoms, hospital admissions.[317] Causes coughing and choking, nausea, headache, abdominal pain, and difficulty breathing.[318]	Asthma and respiratory infections.[319] Very high exposure may cause death, genetic mutations, decreased female fertility, spasms, swelling of the throat, rapid pulse, and dilated heart.[320]
Sulfur Dioxide (SO2)	Inflames and irritates the respiratory system and causes breathing difficulties especially during heavy physical activity.[321]	Reduces lung function and causes incidences of respiratory symptoms and diseases.[322] High concentrations can affect lung function, worsen asthma attacks, and worsen existing heart disease.[323]
Dioxins	The most harmful man-made toxins known to humans.[324] Causes poor liver and immune functioning, and neurological impairment.[325]	Causes cancer, reproductive and developmental problems, damage to the immune system, and interference with hormonal systems.[326]
Mercury	Neurological and behavioral disorders.[327] Symptoms include tremors, insomnia, memory loss, neuromuscular effects, headaches and cognitive and motor dysfunction.[328]	Overexposure may cause permanent neurological damage. [329] Toxic effects on the kidneys, nervous, digestive and immune systems, and on lungs, skin and eyes.[330]
Lead	Relatively low levels can disrupt normal development of the central nervous system, especially during fetal life and early childhood.[331] May cause miscarriage, stillbirths, and infertility.[332]	Can affect virtually every organ system.[333] Prolonged exposure may increase risk of high blood pressure, heart disease, and kidney disease. [334]
Particulate Matter >10 µm (includes PM10 and 2.5)	Deposits into the trachea and deeply into the lungs, irritates and corrodes the alveolar wall, and impairs lung functioning.[335] Causes aggravation of asthma, respiratory symptoms and an increase in hospital admissions.[336]	Overall mortality and mortality of lung cancer increases by 4%, 6% and 8%, respectively, for every 10 µg/m^3 PM2.5 increase.[337] Cardiovascular disease Respiratory disease

APPENDIX E: Dirty Dozen List Tables (2014)

Environmental justice communities are marked with a red square at the start of the row

Emissions data in the table below is sourced from the U.S. EPA ECHO Database

NITROGEN OXIDE MSW Incinerator	City	State	Tonnage per day	Tonnage per year	Nox emissions (2014, pounds)	NOx Rate (pounds per ton of waste)
Mid-Maine Waste Action Corporation	Auburn	ME	200	73000	563,885	7.72
Xcel Energy- Wilmarth Plant	Mankato	MN	720	262800	1,331,571	5.07
Lake County Resource Recovery	Okahumpka	FL	528	192720	950,783	4.93
Oswego County Energy Recovery	Fulton	NY	200	73000	341,157	4.67
Xcel Energy- Red Wing Steam Plant	Red Wing	MN	720	262800	1,226,000	4.67
Pasco County Solid Waste Resource Recovery	Spring Hill	FL	1,050	383250	1,615,941	4.21
Barron County Waste-to-Energy & Recycling	Almena	WI	90	32850	130,658	3.98
Wheelabrator Concord	Penacook	NH	500	182500	702,486	3.85
Pope/Douglas Waste-to-Energy	Alexandria	MN	240	87600	319,023	3.64
Covanta Plymouth Renewable Energy	Conshohocken	PA	1,216	443840	1,586,220	3.58
Wheelabrator Millbury	Millbury	MA	1,500	547500	1,871,826	3.42
Haverhill Resource Recovery	Haverhill	MA	1,650	602250	2,045,774	3.4

SULFUR DIOXIDE MSW Incinerator	City	State	Tonnage per day	Tonnage per year	SO_2 emissions (2014, pounds)	SO_2 Rate (pounds per ton of waste)
Hampton-NASA Steam Plant	Hampton	VA	240	87600	161,040.00	1.84
Barron County Waste-to-Energy & Recycling	Almena	WI	90	32850	42,250.90	1.29
Wheelabrator Millbury	Millbury	MA	1,500	547500	603,770.00	1.1
Wheelabrator Baltimore	Baltimore	MD	2,250	821250	621,703.00	0.76
Palm Beach Renewable Energy #1	West Palm Beach	FL	2,000	730000	491,910.62	0.67
Wheelabrator Concord	Penacook	NH	500	182500	113,259.48	0.62
SEMASS Resource Recovery	West Wareham	MA	3,000	1095000	647,847.60	0.59
Niagara Falls Resource Recovery	Niagara Falls	NY	2,250	821250	450,413.00	0.55
Wheelabrator Portsmouth	Portsmouth	VA	2,000	730000	398,981.58	0.55
Mid-Maine Waste Action Corporation	Auburn	ME	200	73000	35,986.98	0.49
Xcel Energy French Island Generating Station	La Crosse	WI	400	146000	65,811.60	0.45
Pope/Douglas Waste-to-Energy	Alexandria	MN	240	87600	39,136.10	0.45

APPENDIX E: Continued

LEAD MSW Incinerator	City	State	Tonnage per day	Tonnage per year	Lead emissions (2014, pounds)	Lead Rate (pounds per ton of waste)
Wheelabrator Hudson Falls	Hudson Falls	NY	500	182500	289.83	0.0016
Polk County Solid Waste Resource Recovery	Fosston	MN	80	29200	45.37	0.0016
Bay County Waste-to-Energy	Panama City	FL	500	182500	197.95	0.0011
Covanta Camden Energy Recovery Center	Camden	NJ	1,050	383250	380.00	0.0010
Essex County Resource Recovery	Newark	NJ	2,277	831105	631.80	0.0008
Wheelabrator Gloucester	Westeville	NJ	500	182500	95.20	0.0005
ecomaine Waste-to-Energy	Portland	ME	550	200750	80.20	0.0004
Wheelabrator Baltimore	Baltimore	MD	2,250	821250	293.93	0.0004
Hampton-NASA Steam Plant	Hampton	VA	240	87600	26.53	0.0003
Susquehanna Resource Management Complex	Harrisburg	PA	800	292000	77.20	0.0003
Mid-Maine Waste Action Corporation	Auburn	ME	200	73000	17.90	0.0002
Covanta Tulsa Renewable Energy	Tulsa	OK	750	273750	66.00	0.0002

MERCURY MSW Incinerator	City	State	Tonnage per day	Tonnage per year	Mercury emissions (2014, pounds)	Mercury Rate (pounds per ton of waste)
Babylon Resource Recovery	West Babylon	NY	750	273750	319.79	0.001168
Hampton-NASA Steam Plant	Hampton	VA	240	87600	21.29	0.000243
Wheelabrator Hudson Falls	Hudson Falls	NY	500	182500	26.00	0.000142
Pinellas County Resource Recovery	St. Petersburg	FL	3,150	1149750	134.89	0.000117
Barron County Waste-to-Energy & Recycling	Almena	WI	90	32850	3.83	0.0001165
Bay County Waste-to-Energy	Panama City	FL	500	182500	18.16	0.0000995
Dutchess County Resource Recovery	Poughkeepsie	NY	450	164250	15.96	0.0000869
Susquehanna Resource Management Complex	Harrisburg	PA	800	292000	25.40	0.00006714
Essex County Resource Recovery	Newark	NJ	2,277	831105	55.80	0.0000641
Wheelabrator Baltimore	Baltimore	MD	2,250	821250	52.68	0.000064
MacArthur Waste-to-Energy	Ronkonkoma	NY	486	177390	11.36	0.0000597
Marion County Solid Waste-to-Energy	Brooks	OR	550	200750	12.00	0.0000562

APPENDIX E: Continued

PM2.5 MSW Incinerator	City	State	Tonnage per day	Tonnage per year	PM2.5 emissions (2014, pounds)	PM2.5 Rate (pounds per ton of waste)
Wheelabrator Gloucester	Westeville	NJ	500	182500	70,463.00	0.39
Olmsted Waste-to-Energy	Rochester	MN	400	146000	31,577.00	0.22
Delaware Valley Resource Recovery	Chester	PA	2,688	981120	201,191.11	0.21
Wheelabrator Falls	Morrisville	PA	1,500	547500	108,230.44	0.2
Essex County Resource Recovery	Newark	NJ	2,277	831105	153,748.40	0.18
Palm Beach Renewable Energy #1	West Palm Beach	FL	2,000	730000	133,364.59	0.18
Honolulu Resource Recovery Venture	Kapolei	HI	3,000	1095000	182,757.22	0.17
Pinellas County Resource Recovery	St. Petersburg	FL	3,150	1149750	191,063.17	0.17
Covanta Camden Energy Recovery Center	Camden	NJ	1,050	383250	59,094.80	0.15
Montgomery County Resource Recovery	Dickerson	MD	1,800	657000	98,760.26	0.15
Lancaster County Resource Recovery	Bainbridge	PA	1,200	438000	57,033.04	0.13
Spokane Waste-to-Energy	Spokane	WA	800	292000	33,400.00	0.11

PM10 MSW Incinerator	City	State	Tonnage per day	Tonnage per year	PM10 emissions (2014, pounds)	PM10 Rate (pounds per ton of waste)
Wheelabrator Gloucester	Westeville	NJ	500	182500	70,472.00	0.39
Palm Beach Renewable Energy #1	West Palm Beach	FL	2,000	730000	233,481.65	0.32
Olmsted Waste-to-Energy	Rochester	MN	400	146000	34,562.30	0.24
Pinellas County Resource Recovery	St. Petersburg	FL	3,150	1149750	248,555.57	0.22
Wheelabrator Falls	Morrisville	PA	1,500	547500	117,515.00	0.21
Honolulu Resource Recovery Venture	Kapolei	HI	3,000	1095000	207,877.43	0.19
Essex County Resource Recovery	Newark	NJ	2,277	831105	153,750.40	0.18
Susquehanna Resource Management Complex	Harrisburg	PA	800	292000	51,696.80	0.18
Montgomery County Resource Recovery	Dickerson	MD	1,800	657000	102,090.80	0.16
Covanta Camden Energy Recovery Center	Camden	NJ	1,050	383250	59,094.80	0.15
Spokane Waste-to-Energy	Spokane	WA	800	292000	41,600.00	0.14
Bay County Waste-to-Energy	Panama City	FL	500	182500	25,131.29	0.14

APPENDIX E: Continued

Carbon Monoxide MSW Incinerator	City	State	Tonnage per day	Tonnage per year	CO emissions (2014, pounds)	CO Rate (pounds per ton of waste)
Palm Beach Renewable Energy #1	West Palm Beach	FL	2,000	730000	1,278,240.83	1.75
Bay County Waste-to-Energy	Panama City	FL	500	182500	298,058.13	1.63
Wheelabrator Hudson Falls	Hudson Falls	NY	500	182500	201,226.82	1.1
Miami-Dade County Resource Recovery	Doral	FL	4,200	1533000	1,532,163.55	1
Dutchess County Resource Recovery	Poughkeepsie	NY	450	164250	160,557.00	0.98
Xcel Energy- Wilmarth Plant	Mankato	MN	720	262800	234,146.38	0.89
Mid-Maine Waste Action Corporation	Auburn	ME	200	73000	58,108.53	0.8
SEMASS Resource Recovery	West Wareham	MA	3,000	1095000	777,220.60	0.71
Southeastern Connecticut Resource Recovery	Preston	CT	669	244185	166,789.51	0.68
Connecticut Solid Waste System Resource Recovery	Hartford	CT	2,850	1040250	692,894.45	0.67
Hampton-NASA Steam Plant	Hampton	VA	240	87600	54,664.65	0.62
Wheelabrator Portsmouth	Portsmouth	VA	2,000	730000	448,816.25	0.61

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