



| Trash in America

Moving from destructive consumption
towards a zero-waste system

2021 EDITION

MoPIRG
Foundation



FRONTIER GROUP

Trash in America

Moving from destructive consumption
towards a zero-waste system

MoPIRG
Foundation



FRONTIER GROUP

ADRIAN PFORZHEIMER, FRONTIER GROUP
ALEXANDER TRUELOVE, U.S. PIRG EDUCATION FUND

SEPTEMBER 2021

Acknowledgments

The authors wish to thank Kate Bailey and Rachel Setzke of Eco-Cycle for their review of drafts of this document, as well as their insights and suggestions. Thanks to Abi Bradford for authoring the previous version of this report. Thanks also to Susan Rakov, Tony Dutzik, James Horrox, Gideon Weissman, Elizabeth Ridlington and Lauren Phillips-Jackson of Frontier Group for editorial support.

The authors bear responsibility for any factual errors. Policy recommendations are those of MoPIRG Foundation, Environment Missouri Research & Policy Center and Community Action Works. The views expressed in this report are those of the authors and do not necessarily reflect the views of our funders or those who provided review.

This is an update of a report originally released in February 2018.

©2021 MoPIRG Foundation. Some Rights Reserved. This work is licensed under a Creative Commons Attribution 4.0 International license. To view the terms of this license, visit creativecommons.org/licenses/by/4.0/.



With public debate around important issues often dominated by special interests pursuing their own narrow agendas, MoPIRG Foundation offers an independent voice that works on behalf of the public interest. MoPIRG Foundation, a 501(c)(3) organization, works to protect consumers and promote good government.

We investigate problems, craft solutions, educate the public, and offer meaningful opportunities for civic participation. For more information about MoPIRG Foundation or for additional copies of this report, please visit mopirgfoundation.org.



Environment Missouri Research & Policy Center is a project of Environment America Research & Policy Center, a 501 (c)(3) organization. We are dedicated to protecting our air, water and open spaces. We investigate problems, craft solutions, educate the public and decision-makers, and help the public make their voices heard in local, state and national debates over the quality of our environment and our lives.

For more information about Environment Missouri Research & Policy Center or for additional copies of this report, please visit www.environmentmissouricenter.org.



Frontier Group provides information and ideas to build a healthier, more sustainable America. We focus on problems that arise from our nation's material and technological wealth – the problems of abundance. We deliver timely research and analysis that is accessible to the public, applying insights gleaned from diverse fields of knowledge to arrive at new paths forward. For more information about Frontier Group, please visit www.frontiergroup.org

Layout: To the Point Collaborative, tothepointcollaborative.com

Cover photo: Michael Courier, www.michaelcourier.com

| Contents

- EXECUTIVE SUMMARY 4
- INTRODUCTION 8
- AMERICA PRODUCES TOO MUCH WASTE..... 10
 - How much solid waste does the U.S. produce? 10
 - What does America throw away? 10
 - What does the U.S. do with its garbage? 11
 - What are the impacts of America’s waste system? 12
 - Global warming..... 12
 - Air pollution..... 13
 - Water contamination..... 14
 - Ocean pollution..... 14
 - Wasted natural resources..... 16
 - Why does the U.S. throw out so much stuff? 17
 - Goods are cheap 17
 - Most goods are made to be used once and thrown away 18
 - There are few direct incentives to repair, reuse, recycle and compost..... 18
- MOVING AMERICA TO ZERO WASTE..... 20
 - Steps to achieving a zero-waste system..... 22
- NOTES 29

| Executive summary

THE UNITED STATES produces too much waste.

Natural resources are continually extracted to produce goods that are used in the U.S. – often only briefly – before they are thrown into landfills, incinerators or the natural environment. This system of consumption and disposal results in the waste of precious resources and pollution that threatens our health, environment and the global climate.

Because the costs of this system fall on society at large – not on the producers and consumers who drive it – there are few direct incentives for change.

To protect public health and the environment, conserve natural resources and landscapes, and address the mounting crisis of climate change, America should move toward an economic system characterized by zero waste. To achieve that goal, **federal, state and local governments should enact policies and programs that incentivize shifting to a “circular” or “closed-loop” economy in which less is consumed and all materials are reused, recycled and composted in a continuous cycle.**

The U.S. produces more than 12% of the planet’s trash*, though it is home to only 4% of the world’s population.¹

- In 2018 alone, the U.S. threw out over 292 million tons of municipal solid waste (MSW) – the materials discarded by homes, businesses and institutions, such as universities and libraries.²

- Americans throw out 4.9 pounds of trash per person every day – that’s nearly **1,800 pounds of materials per American every year.**³

- The majority of waste (62%) discarded by homes and businesses in the U.S. is ultimately dumped into landfills or burned in incinerators.⁴

More than 91% of plastic was landfilled or incinerated in 2018.⁵

Every 15.5 hours, Americans throw out enough plastic to fill the largest NFL stadium in the country, AT&T Stadium (the home of the Dallas Cowboys), and the pile grows larger every year.⁶

Our trash leads to even more waste than we see. The products we use and dispose of are created by processes like mining and manufacturing, which generate far more, and far more dangerous, waste.⁷

America’s garbage largely consists of goods that are used only briefly.

Over 28% of all U.S. garbage is packaging, amounting to 82 million tons of material that is typically thrown out after a product is purchased or used.⁸

Nondurable goods, such as clothing and newspaper, account for 17.3% of U.S. garbage, with yard trimmings (12.1%) and food (21.6%) accounting for a substantial share as well.⁹

The remainder (19.5%) of what homes and businesses throw out is made up of durable

* In this paper, the terms “garbage” and “trash” will be used in place of “Municipal Solid Waste,” which refers to materials discarded by homes, businesses and institutions, such as universities and government agencies.

goods, like furniture and appliances, many of which could be repaired or repurposed, or have their materials recycled for other uses.¹⁰

America's linear material economy, where materials are extracted, made into goods, and disposed of, is a one-way street that creates massive environmental and public health impacts.

- **Global warming pollution: Roughly 42% of all U.S. greenhouse gas emissions** are created in the process of extracting resources, producing goods, disposing of waste, and transporting materials at every stage of that process.¹¹
- **Air pollution:** Incinerator emissions include heavy metals and mercury, a neurotoxin that impairs brain function, as well as cancer-causing pollutants like dioxin, one of the most toxic substances known to humanity.¹² The extraction and production activities that support the linear material economy also cause environmental degradation, air pollution and water contamination.
- **Water contamination:** Leachate from landfills can escape into the environment and threaten drinking water supplies.¹³
- **Ocean pollution:** An estimated 16.5 million tons of plastic washes into the world's oceans every year.¹⁴ This plastic persists for hundreds of years and can kill marine animals by entangling them, poisoning them or blocking their digestive tracts.¹⁵ Marine debris is considered one of the great threats to biodiversity.¹⁶
- **Wasted natural resources:** It would take 321 million trees to produce the amount of paper that was landfilled or burned in the U.S. in 2018 alone.¹⁷ Thirty million acres of cropland, roughly the area of Pennsylvania, is farmed each year for food that is wasted in the U.S.¹⁸

America's system of consumption and disposal encourages and incentivizes waste.

Society bears most of the costs and burdens of waste – not the producers and consumers who create it – removing incentives for change.

- Producers have few direct incentives to build products to last, to make them easy to repair, to use less packaging, or to make their goods or packaging easy to reuse, recycle or compost. In fact, it is often beneficial for producers to make goods intended to be used once or only temporarily so that consumers continually buy more.
- Producers, distributors and waste haulers have a stake in the U.S. waste system continuing to operate as it does now and have lobbied against changes.¹⁹

A zero-waste economy is possible.

Nearly all of America's trash could be composted and recycled.

- **Food waste and yard trimmings** make up more than a third (33.7%) of U.S. garbage

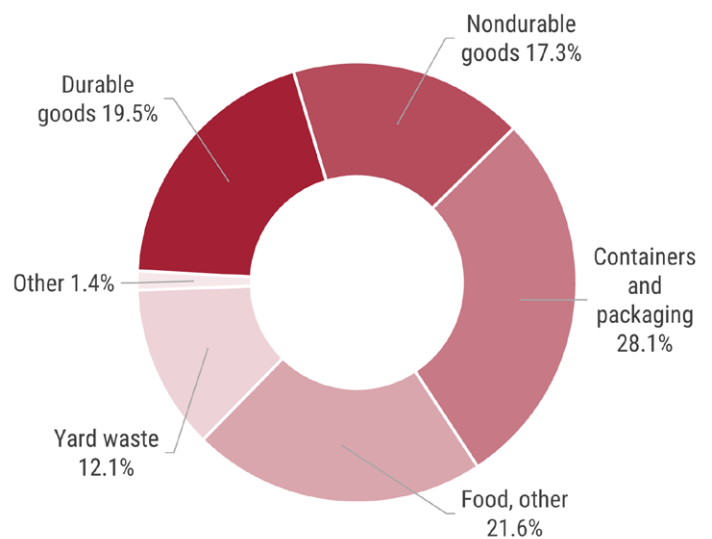


Figure ES-1. U.S. garbage composition by product category, 2018²⁰

and are organic and easily compostable, but the U.S. lacks sufficient infrastructure.²¹

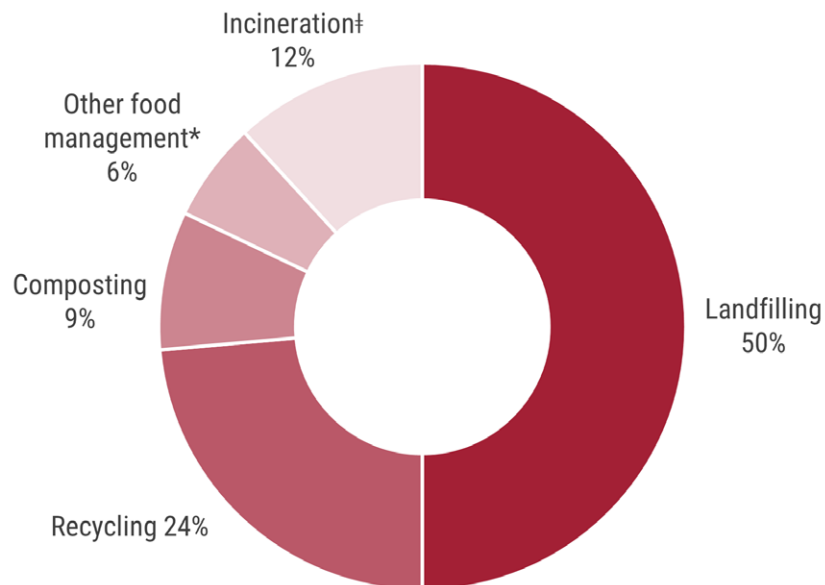
- **Paper and paperboard**, some of which could be composted and the rest of which could be recycled, make up nearly a quarter (23.1%) of America’s trash.²²
- **Metals, glass, and plastics** – another quarter (25.2%) of America’s garbage – are all readily recyclable, although many types of plastic are not.²³
- **Rubber, wood, leather, and textiles** make up the remainder (15.1%) of America’s waste and can also be recycled into useful products.²⁴ Textile recycling has made great advances in recent years.

U.S. cities and states, as well as other countries, are already taking strides toward creating zero waste.

- **Eleven states** have passed bans on single-use plastic bags, seven states have passed

bans on expanded polystyrene containers, and more are considering bans on other single-use foodware, packaging and more.²⁵

- Several states have banned recyclables from landfills, and in 2020 Vermont became the first to ban **all compostable materials from landfills**.²⁶
- Thanks to a variety of policies and programs, such as making manufacturers responsible for disposing of packaging, **Germany now recycles 67% of household waste**.²⁷
- In July 2021, Maine became the first state in the U.S. to pass a law establishing producer responsibility for packaging and paper products, shifting responsibility for the costs of recycling away from the taxpayer and onto the corporations responsible for producing those products.²⁸



* “Other food management” includes animal feed, bio-based materials/biochemical processing, codigestion/anaerobic digestion, donation, land application and sewer/wastewater treatment.

‡ “Incineration” refers to combustion with energy recovery.

Figure ES-2. U.S. garbage handling, 2018²⁹

America has the tools to shift away from this wasteful, polluting and costly linear system to a circular material economy that produces zero waste, conserves natural resources, and limits pollution and global warming emissions.

Efforts to reduce waste should prioritize reducing material consumption first and foremost; reusing, refurbishing and repairing everything possible; and recycling or composting all remaining materials.

By taking the following steps, the U.S. can incentivize the shift to a circular economy in which zero waste is created. These steps can be promoted through a variety of policies and programs at the local, state and national levels.

1. Set a goal to achieve zero waste.
2. Require producers to take responsibility for their products during their entire life cycle.
3. Price goods to reflect the environmental and public health impacts of their production.
4. Make recycling and composting mandatory, universally accessible and less expensive than garbage disposal.
5. Require that goods be built to last and easy to repair, reuse, recycle or compost.
6. Ban the sale of single-use items that are not easily recyclable or compostable, including packaging, plastic bags and food service ware.
7. Invest in repair, reuse, recycling and composting facilities to support a circular economy.
8. Require producers to use recycled and reused materials in new products, and encourage businesses and governments to set procurement standards for recycled materials.
9. As waste is eliminated, ensure that all remaining waste is disposed of safely.
10. Oppose the construction, expansion and subsidization of landfills, incinerators and plastic-to-fuel conversion facilities marketed as “chemical recycling.”

| Introduction

THE ITEMS WE THROW in the trash or in the recycling bin seem to go “away” – picked up off our curbs weekly and immediately put out of our minds.

But there is no “away.” The trash we discard often comes back into our lives – sometimes as a product made with recycled material, but more often as plastic litter in a beach or park, or pollution from an incinerator.

For decades, America has sent much of its trash halfway around the world in search of a new “away.”

Since 1992, for example, China and Hong Kong accepted over 72% of the world’s plastic waste imports.³⁰ The United States exported over 750,000 tons of plastic to China in 2016 alone, outsourcing the sorting and recycling of low-value plastic scrap.³¹ This made “recycling” in the U.S. cheap and easy, allowing for the export of even imperfectly sorted plastic waste. Every day, ships in U.S. ports unloaded products from China and filled nearly 4,000 shipping containers full of mixed recyclables.³²

The waste we produced and shipped contributed to a 66 billion to 77 billion ton backlog in China.³³ Managing this waste and its pollution became so unsustainable that in January 2018, China banned almost all imports of mixed waste and plastic scrap.³⁴

Exporters frantically searched for the next “away” – turning to nearby southeast Asian countries with underdeveloped recycling infrastructure to offload their scrap. U.S.

plastic waste exports to Thailand jumped nearly 7,000% in one year.³⁵ Alarmed at the influx, Thailand and many other neighboring countries passed import restrictions of their own – forcing America to finally confront the huge volume of waste we produce.³⁶

With little domestic infrastructure to sort and reuse our own trash, the cost of recycling skyrocketed. In California, a bale of low-grade mixed plastic that could be sold for \$20 in 2017 cost \$10 to dispose of a year later.³⁷ Philadelphia, looking at a fourfold increase in the price of recycling, started sending at least half of its recycling straight to an incinerator.³⁸ Franklin, New Hampshire, which had sold recycling for \$6 a ton, now faced fees of \$125 a ton to dispose of recycling at the local transfer station.³⁹ Franklin became one of over 100 U.S. towns to cut or pause its curbside recycling program since 2018.⁴⁰

Today, with fewer opportunities to send our plastic waste “away,” America faces a choice: Continue down a pathway of increased materials production and pollution – a future in which communities and our environment increasingly buckle under the cost and strain of dealing with an ever-increasing flow of garbage. Or boldly reimagine our entire relationship to the stuff we buy, use and throw away.

A zero-waste path is possible – one in which we use less stuff, recycle and repair more of what we own, and relieve our communities and our environment of the burden of dealing with ever-increasing volumes of trash. We can achieve it by setting zero-waste

targets, such as decreasing the overall tonnage of waste we produce and increasing the landfill diversion rate, and then putting in place the commitments, policies and programs that can make that economy a reality.

There are proven, common-sense policies that can be enacted at the local, state and national levels that can begin to change this system. Governments can follow the example of San Francisco, which now requires that all food service packaging sold in the city, like coffee cups, be recyclable or compostable.⁴¹ Or they can follow the lead of states such as Hawaii, Washington, Maine, and New Jersey and communities across the U.S. that have banned plastic bags from grocery stores.⁴² To be even more ambitious, states and the

federal government can follow the longtime leadership of countries like Germany, which has shifted responsibility for the entire life cycle of packaging to producers, dramatically increasing recycling rates.⁴³ In 2021, Maine became the first state in the U.S. to pass such a law. LD 1541 – “An Act to Support and Improve Municipal Recycling Programs and Save Taxpayer Money” – requires companies using certain kinds of packaging materials to cover the recycling costs of those materials.⁴⁴

By coming to grips with our nation’s absurd, linear material economy, and by putting the right policies and signals in place, America can move toward a more sustainable future – one that recognizes that there is no such place as “away.”

Photo: Walter Parenteau via Flickr, CC BY-NC-ND 2.0



Bales of plastic are collected at Recycle Central at Pier 96 in San Francisco. Better sorting technology leads to cleaner bales and more opportunities to sell them.

America produces too much waste

How much solid waste does the U.S. produce?

The U.S. produces more than 12% of the planet's municipal solid waste (MSW), though it is home to only 4% of the world's population.⁴⁵ Behind this mountain of trash, however, is a larger one created by industrial processes, often to make our household products that in turn, in many cases, end up as the waste we throw out. Activities like mining, manufacturing and agriculture create industrial solid waste, which is poorly tracked but may account for up to 97% of America's total waste.⁴⁶

Based on available data, the categories of solid waste in America, ranked by size are:

Industrial solid waste: approximately 7.6 billion tons per year (2003 estimate).⁴⁷

Mining and mineral processing solid waste: 1-2 billion tons per year (2004 estimate).⁴⁸

Construction and demolition debris: 600 million tons (2018 estimate).⁴⁹

Municipal solid waste or garbage from homes, businesses and institutions: 292.4 million tons (2018 estimate).⁵⁰

Oil and gas exploration and production solid waste: 107 million tons per year (2016 estimate). This figure does not include 4.5 billion tons of contaminated water per year.⁵¹

Hazardous solid waste covered by the Resource Conservation Recovery Act (RCRA): 28.9 million tons (2017 estimate).⁵²

What does America throw away?

The materials thrown out in the U.S. are largely comprised of goods that are unnecessary or are used only briefly – for example, over 28% of all U.S. garbage is packaging.⁵³

Packaging is the largest single category of waste thrown out in the U.S., amounting to 82 million tons a year of garbage generated by materials of little direct use to the consumer.⁵⁴ Consumer goods, including durable goods (e.g., furniture, appliances and other products which are intended to last) and nondurable goods (e.g., newspapers, clothing and other products intended to wear out), together comprise 36.8% of garbage – with a slightly higher amount of durable goods than non-durable goods.

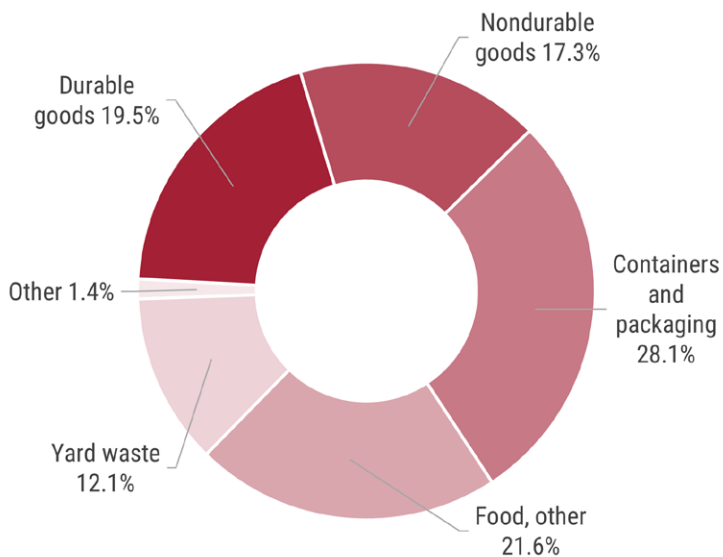


Figure 1. U.S. garbage composition by product category, 2018⁵⁵

More than one-third of discarded materials are organic, and are therefore compostable, while over half are reusable or recyclable. The components of U.S. municipal garbage include:

1. Organic material (food & yard trimmings): 33.7%
2. Paper & paperboard: 23.1%
3. Plastics: 12.2%
4. Rubber, leather and textiles: 8.9%
5. Metals: 8.8%
6. Wood: 6.2%
7. Glass: 4.2%

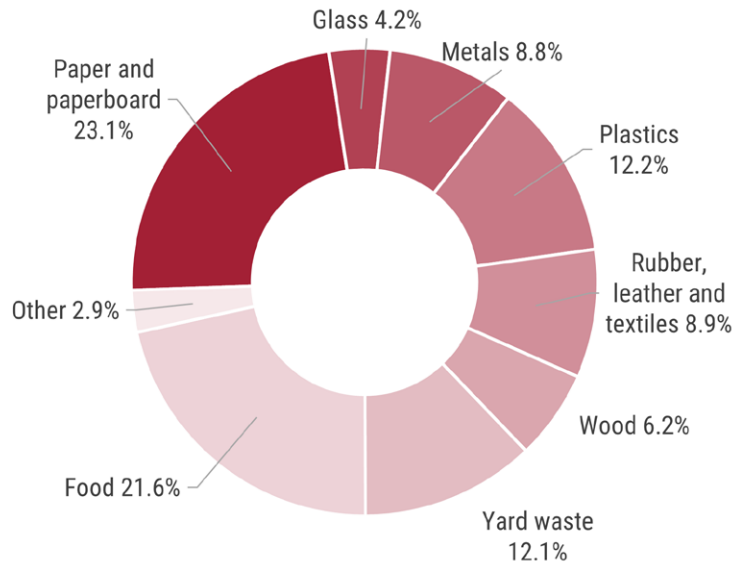


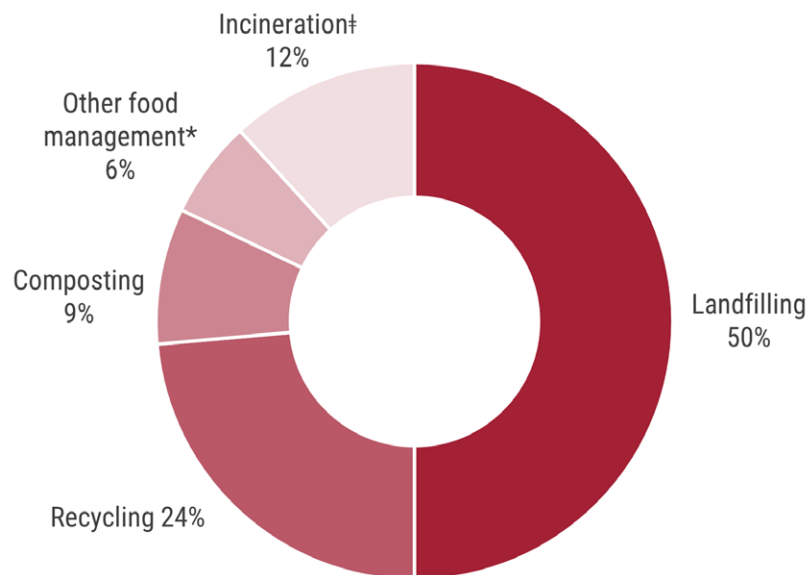
Figure 2. U.S. garbage composition by material, 2018⁵⁶

What does the U.S. do with its garbage?

Nearly two-thirds – 61.8% – of garbage thrown out in the U.S. is ultimately dumped into landfills or burned in incinerators. Far less material – 38.2% – is composted, recycled or otherwise diverted from disposal; some of it is exported to

an unknown fate.⁵⁷ A great deal of unaccounted-for trash also ends up loose in the environment in the form of litter.

Because most discarded materials are dumped or burned, there are currently 2,629 landfills and 75 incinerators with energy recovery in the U.S.⁵⁸



* “Other food management” includes animal feed, bio-based materials/biochemical processing, codigestion/anaerobic digestion, donation, land application and sewer/wastewater treatment.

‡ “Incineration” refers to combustion with energy recovery.

Figure 3. U.S. garbage handling, 2018⁵⁹

Less than a quarter of trash in America is recycled. Single-stream recycling, where different materials are disposed of in the same bin and sorted at a recycling plant, is the most common method, covering 80% of American communities in 2014.⁶⁰ While single-stream is the simplest way to recycle, around 20% of the material collected in such systems is contaminated or unrecyclable.⁶¹

Only 6.1 million households had access to curbside food composting in 2017, resulting in just 4.1% of wasted food being composted in 2018.⁶² However, many communities have specific pick-up programs for yard trimmings, helping the U.S. achieve a composting rate of 63% for of yard waste.⁶³

What are the impacts of America's waste system?

America's linear economy and waste system create massive environmental and public health impacts.

GLOBAL WARMING

The U.S. generates more CO₂ emissions than any country other than China.⁶⁴ The consumptive or "embedded" emissions from the U.S. waste system – that is, emissions from the activities that the system perpetuates, such as extracting resources, producing goods, disposing of waste, and transporting materials at every stage of that process – collectively account for **42% of all U.S. greenhouse gas emissions.**⁶⁵

That is more than any individual sector of the U.S. economy, such as transportation (29%) or electricity generation (25%), though these sectors do overlap with the material economy.⁶⁶

Cutting back on these emissions by consuming less would therefore be one of the most effective strategies to cut global warming pollution. It would also reduce the unaccounted-for emissions from countries

around the world that manufacture products and raw materials we consume.

Using recycled materials instead of virgin materials for manufacturing saves energy and keeps materials out of incinerators and landfills, both of which save significant amounts of climate pollution.⁶⁷ In 2018, recycling and composting in the U.S. prevented more greenhouse gas emissions than almost 42 million passenger cars produce in a year.⁶⁸ One 2008 study estimated that reducing waste generation and disposal via zero waste strategies could enable the U.S. to reduce its greenhouse gas emissions by more than 406 million metric tons of CO₂ equivalent per year by 2030 – equivalent to shutting down one-fifth of the coal-fired power plants in operation in the U.S. at the time that study was conducted.⁶⁹

Food waste and yard trimmings, which make up 31.4% of waste sent to landfills, produce methane – a greenhouse gas 86 times more potent than carbon dioxide in the short term – as they degrade in dark, low-oxygen conditions.⁷⁰ This is a large missed opportunity, because composting organic matter builds soil and traps carbon by helping microorganisms and plants to grow. In 2019, landfill methane produced the equivalent of 114.5 million metric tons of CO₂.⁷¹

Using recycled material instead of virgin materials also saves significant amounts of energy – according to the Institute of Scrap Recycling Industries, up to 95% for aluminum, 75% for copper, 88% for plastic, 60% for paper, 60% for steel and 34% for glass. It also conserves natural resources. Recycling 1 ton of steel conserves 2,500 pounds of iron ore, 1,400 pounds of coal and 120 pounds of limestone; and recycling 1 ton of aluminum conserves more than 4 metric tons of bauxite ore.⁷²

AIR POLLUTION

Most waste ends up in landfills, which release toxic air pollution. Construction and demolition debris that contains drywall can produce toxic hydrogen sulfide gas in landfills.⁷³ Hydrogen sulfide is a colorless, highly flammable and explosive gas that smells like rotten eggs.⁷⁴ Hydrogen sulfide can cause eye and skin irritation; problems with respiratory, cardiovascular and neurological systems, among others; cancer; and, in cases of acute exposure, death.⁷⁵

Incinerators work by burning waste material at extremely high temperatures, producing ash and air pollution. Some of these emissions include cancer-causing and highly toxic pollutants like dioxin, which

can cause skin, blood, liver and reproductive problems.⁷⁶ Incinerators also release heavy metals and mercury, a neurotoxin that impairs brain function.⁷⁷

A recent development in waste disposal is the concept of turning plastic waste into fuel by treating it with various chemicals, heat and pressure through technologies such as pyrolysis and gasification. These processes break apart plastics in high heat and low oxygen conditions and release dangerous chemicals, including hydrogen cyanide, carbon monoxide, and new carcinogenic molecules not present in the original plastic.⁷⁸ Toxic and environmentally harmful materials can then end up in the facility's waste streams.⁷⁹

Photo: Doug Bradley via Flickr, CC BY-NC-ND 2.0



Air pollution from the Blue Ridge Paper Mill in the town of Canton, North Carolina. Because the vast majority of manufactured materials in the U.S. are ultimately dumped or burned, materials such as paper need to be continually made anew. The processes by which these new materials are made create air, water and global warming pollution.

While the extent of the risk to facility workers and neighboring communities remains unknown, existing pyrolysis and gasification facilities for plastic waste have been linked to hazardous emissions that pose health risks to workers and nearby residents. Gasification of plastic produces carcinogens that can be disruptive to respiratory or neurological systems, including phthalates, BPA and toxic brominated compounds.⁸⁰

According to a European Commission report on plastic recycling, detailed knowledge of the environmental impacts and possible unintended consequences of industrial-scale chemical recycling “does not exist.”⁸¹ A report by the nonprofit group Global Alliance for Incinerator Alternatives (GAIA) concluded, “The only thing [plastic to fuel] recycles is toxic chemicals.”⁸² Furthermore, diesel fuel produced via chemical recycling emits higher levels of pollutants, including nitrogen oxides, soot, carbon monoxide and carbon dioxide.⁸³

Dumping and burning garbage rather than reusing and recycling materials necessitates perpetual extraction, manufacturing and transportation activities, all of which also create air pollution.

WATER CONTAMINATION

The liquid that filters through landfills is called leachate, a complex mix of chemicals and contaminants that varies depending on the makeup of the landfill. Toxic leachate can threaten drinking water supplies, even when landfills are protected with modern plastic liners.⁸⁴ Treated leachate is sometimes released into surface waters, but a study by the U.S. Geological Survey found that even after wastewater treatment, leachate still contained potentially hazardous levels of contaminants.⁸⁵

Industrial waste is also often contaminated with dangerous or toxic substances and dis-

posed of with little regulation or oversight. For example, 11 million pounds of radioactive fracking waste was spread on Pennsylvania roads in 2016 – legally – for de-icing and dust control.⁸⁶

The U.S. has 2,629 active landfills and many retired ones.⁸⁷ Almost all need some level of monitoring, and some pose significant threats to the environment.

For example, the town of Lewisville, Texas alleged in a 2012 federal lawsuit that the Camelot Landfill posed “an imminent and substantial endangerment” to its drinking water supply.⁸⁸ Monitoring wells outside the landfill near the Elm Fork of the Trinity River were found to be contaminated with heavy metals and chlorinated hydrocarbons, which can impact central nervous system function and cause kidney damage.⁸⁹ The groundwater at Lees Lane Landfill in Louisville, KY, was tested in 2012 and found to contain arsenic levels up to 38 times the federal limit for drinking water, and lead contamination levels as high as 130 parts per billion, nearly nine times the federal action level.⁹⁰

OCEAN POLLUTION

Much of our trash ends up loose in the environment and is eventually carried into the ocean via stormwater runoff, littering and illegal dumping. An estimated 16.5 million tons of plastic ends up in the ocean every year, and that figure could grow sharply by 2040.⁹¹ A 2020 study estimated that there were 165 million tons of plastic in the world’s oceans, which may not biodegrade for centuries, if ever.⁹² The Pacific Ocean contains a massive garbage patch which is estimated to be about twice the size of Texas and has been growing continuously.⁹³

A 2014 study estimated that there were at least 5.25 trillion pieces of floating plastic in the world’s oceans.⁹⁴ The majority of particles accumulate on the sea floor or break down



A Northern fur seal with a fishing net around its neck.

into smaller and smaller pieces, and eventually into harmful chemicals, which persist indefinitely in the environment.⁹⁵ All of these bits of plastic are harmful to marine species and a potential contributing factor to species extinction.⁹⁶ This is a problem for people who eat seafood, too. One study

found that seafood eaters consume up to 11,000 microplastic particles every year, some of which accumulate in the body over time and may lead to long-term health impacts.⁹⁷ In fact, humans may consume an average of five grams of microplastics per week, or the equivalent of a credit card.⁹⁸

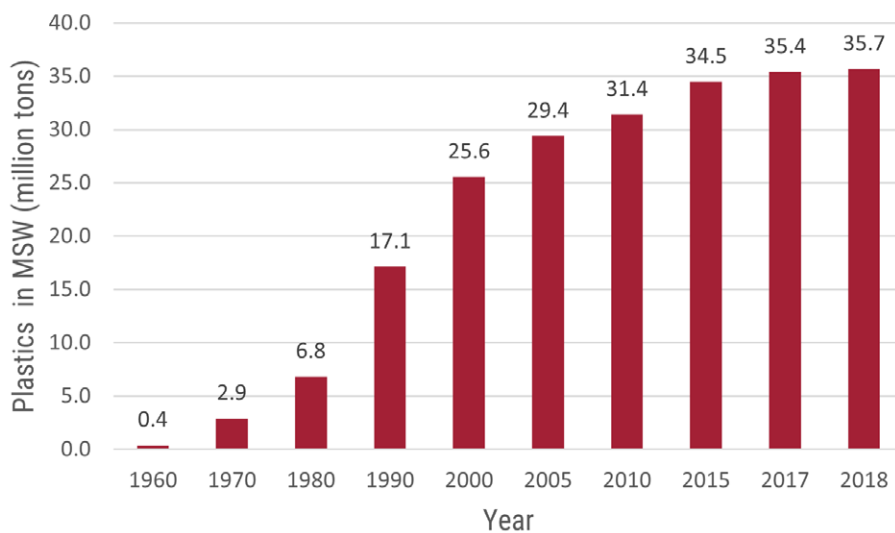


Figure 4. Since the 1960s, the amount of plastic produced has radically increased¹⁰²

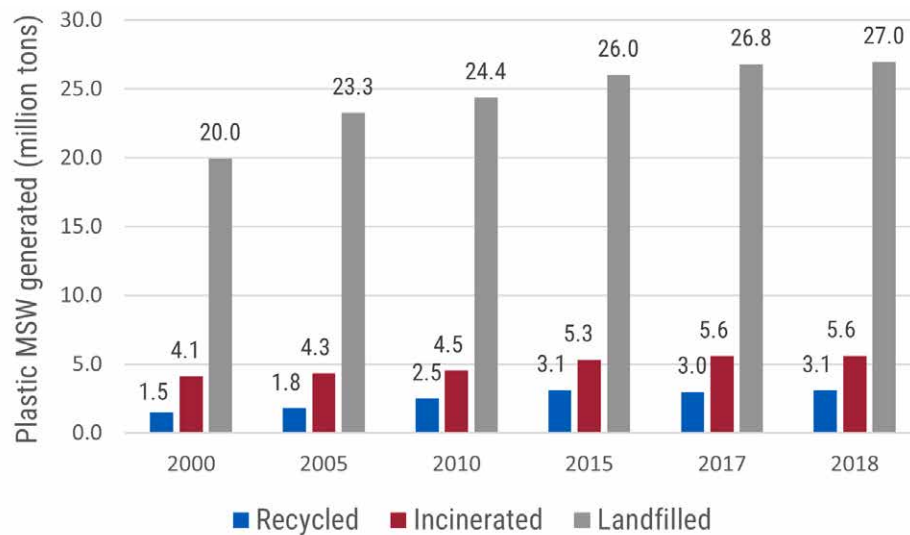


Figure 5. As plastic generation has increased, plastic recycling has stalled¹⁰³

Marine mammals also frequently ingest plastic, mistaking it for food or consuming it inadvertently. One study found plastic in over 60% of dead sea turtles' digestive tracts.⁹⁹ Larger pieces of plastic can also harm or kill seals and whales by entangling them – based on annual entanglement figures, the same study found that this affects at least 57,000 whales and seals every year.¹⁰⁰ This tragedy is not limited to the seas – wildlife entanglement has been recorded in over 270 species.¹⁰¹

WASTED NATURAL RESOURCES

Virgin raw materials often cost less than post-consumer recycled content, but only because of the heavy subsidization of virgin extraction, the fact that the natural resources that produce them are so undervalued, and the failure to incorporate the environmental and social costs of their extraction into their price. It took at least 321 million trees to produce the amount of paper that was landfilled or burned in the U.S. in 2018 alone.¹⁰⁴ An area of Canada's boreal forest the size of Ohio has been cut

down over the past 20 years, largely to manufacture paper products that could be made out of recycled material.¹⁰⁵

The impact of food waste reverberates throughout our globalized world. Each year, 30 million acres of cropland, roughly the area of Pennsylvania, is farmed for food that is wasted in the U.S.¹⁰⁶ Globally, an area the size of Mexico is farmed for food that is thrown away.¹⁰⁷ Nearly a quarter of all water used for agriculture nourishes crops that become food waste.¹⁰⁸ Because America's food comes from around the world, much of the habitat destruction occurring in other parts of the world is due to American waste.¹⁰⁹

In 2018, the U.S. landfilled or burned 32.6 million tons of plastic, much of it single-use plastic containers and other plastic products for which sustainable replacements are readily available.¹¹⁰ The demand for this quantity of plastic requires large amounts of oil and gas, leaving lasting impacts on the millions of acres of land where the fossil fuels are drilled, transported and refined.

COVID-19 INCREASED HOUSEHOLD WASTE, BUT LASTING IMPACTS ARE UNKNOWN

The COVID-19 pandemic upended every facet of the economy and daily life. People stayed home; they cooked and ordered takeout; businesses idled while medical workers worked around the clock. The U.S. waste system, already far from sustainable, was profoundly affected.

In just two months during the spring of 2020, the U.S. may have generated an entire year's worth of medical waste.¹¹¹ Fueled by takeout food and online shopping, residential waste was up 20% above normal during the height of the spring lockdowns, settling in at 7% to 10% above normal at the end of 2020. Meanwhile, commercial waste fell 10%.¹¹²

The price of oil fell precipitously, and with it, the cost of making virgin plastic and the value of recycled plastic. The recycled plastic used to make drink bottles became 88% more expensive than bottle-grade plastic made from virgin materials, reinforcing the need to move beyond single-use plastics altogether.¹¹³ The supply of recycled materials was

further hit by about 100 cities and towns suspending curbside municipal recycling services during the pandemic due to budget and safety concerns.¹¹⁴

COVID-19 also reshaped policies to address the trash crisis. Many communities that had banned single-use plastic bags suspended these bans, uncertain whether reusable bags could spread the virus. Even as it became clear that reusable bags were extremely unlikely to transmit the virus, some cities, states and private businesses were slow to reinstate bans on disposable bags.¹¹⁵

As the U.S. moves beyond the pandemic, it is unclear whether and when changes in waste patterns and litter habits will return to normal. Much will depend on whether states, cities and towns will remain committed to their waste-reduction goals. Forward-thinking communities will look back at the increased trash and ubiquitous litter of masks and takeout containers on streets and in parks during COVID and redouble their zero-waste efforts.

Why does the U.S. throw out so much stuff?

The U.S. throws out immense amounts of materials because goods are relatively cheap to produce and consume, most goods are made to be used once or temporarily, and there are few direct incentives to repair, reuse, recycle and compost materials.

GOODS ARE CHEAP

Before the 20th century, households generated minimal amounts of waste. Raw materials were expensive, manufacturing was relatively inefficient, and most people's

incomes were low. Waste was limited because it made economic sense to only buy what you needed, to repurpose everything, and to produce and purchase durable goods that could be easily repaired.

As the 20th century progressed, however, new technologies made all sorts of products more affordable and disposable, so the barriers to waste fell. A dollar in 2020 buys 44 times the electricity it did in 1902.¹¹⁶ The cost of industrial minerals dropped by roughly 40% from 1900 to 2000.¹¹⁷ With raw materials and energy falling in cost, new and cheaper materials were invented. Modern plastics,

invented in the early 1900s, became very inexpensive to produce and ubiquitous in the latter half of the century. Many industries, inspired by Henry Ford's assembly line, adopted the practice of mass production, which lowered production costs.

At the same time that product costs were falling, people's incomes were rising, further lowering the barriers to consumption and waste production. The median household income in the U.S. more than doubled in 50 years from \$20,102 (in 1997 dollars) in 1947 to \$44,568 in 1997.¹¹⁸

MANY GOODS ARE MADE TO BE USED ONCE AND THROWN AWAY

The 20th century saw the rise of disposable goods and packaging – a development that accelerated dramatically after the widespread introduction of plastic. In 1956, the editor of *National Packaging* magazine declared “the future of plastics is in the trash can.”¹¹⁹ He urged the plastics industry to stop thinking about reusable products and instead to focus on single-use products – things that can be used once and thrown away – because that would create a never-ending sales opportunity. It required behavior change for people to start using disposable goods, but advertising campaigns were effective and now red plastic cups and plastic forks are American staples.

Disposability even began to extend to durable goods. “Planned obsolescence” was thought up in the 1920s, when the national automobile market reached saturation. General Motors famously started introducing new design models every year to convince consumers that their cars were out of date so that they would buy new ones.¹²⁰ Today's smartphones continue that tradition, with designs that make them so difficult to repair they might as well be replaced.

Food waste is another largely modern practice. The U.S. wastes up to 40% of the food it produces – around 133 billion pounds per year.¹²¹ This waste is in large part due to the spread of industrial farming in the 20th century, which has made it cheaper to produce and consume food. Accounting for inflation, milk, ham and sugar in 2013 cost half or less than half as much as they did in 1913, rice cost one-third what it had, and eggs cost only one-quarter what they had a century ago.¹²² Producers and distributors routinely discard food that does not meet high aesthetic standards and transport food long distances with some of it spoiling along the way.¹²³ The relatively low cost of food also allows people to buy more than they eat – a family of four spends \$1,500 every year on food that does not get eaten.¹²⁴

THERE ARE FEW DIRECT INCENTIVES TO REPAIR, REUSE, RECYCLE AND COMPOST

America's wasteful system of extraction, consumption and disposal continues – even though it harms public health and the environment, wastes natural resources, and contributes to dangerous global warming – because its true costs are spread across society and even across generations. The absence of policies that hold companies accountable for managing their packaging and products means that these costs are not felt directly by the producers who create the problem, who therefore have no incentive to change their behavior.

Producers are typically not responsible for the goods they produce after they are sold or their warranty runs out, so they do not have to pay to dispose of those goods when they are ultimately thrown out. Producers, therefore, have little incentive to build products to last, to use less packaging, or to make their goods or packaging easy to repair, reuse, recycle or compost. In fact, it is often beneficial for producers to make

goods intended to be used once or only temporarily so that consumers continually have to buy more.

Similarly, since companies' profits increase when we buy new products, it is in these companies' interests to make it harder to repair our old ones. Many companies have for this reason attempted to control the methods of repair, with some even going so far as to try and block technologies and discourage laws that enable electronics to be repaired.¹²⁵

Many groups have a vested interest in keeping this system as it is. Manufacturers, distributors, retailers and waste haulers have lobbied against measures to limit waste like container deposit laws (bottle bills) and bans on plastic bags, all while lobbying for expansions of their facilities.¹²⁶

In most communities, consumers do not directly pay to throw out their garbage, or they pay the same fee regardless of how much they throw out, so they also have no direct incentives to repair, reuse, recycle and compost.

The broader costs of this system – the harm to public health and the environment, the waste of resources, and the endangerment of future generations through global warming – are also displaced and largely invisible. Even Americans who feel the public health impacts of this system or who see the loss of natural areas may not draw the connections between these burdens and the fact that so many materials are discarded in the U.S.

| Moving America to zero waste

AMERICA HAS THE TOOLS to shift from a wasteful, polluting and costly linear economy to a circular material economy that produces zero waste.

The U.S. material economy is linear – natural resources are extracted to produce goods, which are purchased, used and ultimately thrown out. Because most

materials are ultimately dumped or burned, this process must repeat from the extraction stage to replace those lost materials. Extract, produce, consume, throw out, repeat – this system is effectively a one-way pipeline that converts natural resources into ever-growing piles of garbage and plumes of incinerator smoke.

ZERO WASTE IS POSSIBLE – AN EXAMPLE FROM GERMANY

Thanks to strong public participation and policies that hold producers responsible for their waste, Germany now recycles 67% of its household waste and has a 97% recovery rate for packaging.¹²⁷

- Manufacturers pay a fee on all packaging based on recyclability of packaging materials, encouraging producers to make packaging much easier to recycle.¹²⁸
- There are uniformly colored bins throughout the country for food waste (brown), paper (blue), packaging (yellow), and garbage (black). This simple, universal system makes sorting easy and habitual.
- Manufacturers are required to meet ambitious recycling targets, which have risen over time.¹²⁹

Before construction debris can be disposed of, it must be sorted to a high stan-

dard so it can be easily reused or recycled, leading to an almost 90% recycling rate.¹³⁰

When German manufacturers began paying a fee based on packaging type and volume, plastics in packaging fell by nearly one third, and one million tons of packaging overall was saved over five years.¹³¹

Producer responsibility programs are among the most impactful policy interventions to reduce trash, and interest is growing in the U.S. In February 2021, state legislators representing nine states announced a coordinated plan to introduce producer responsibility legislation in their states.¹³² In 2021, Maine became the first U.S. state to pass such legislation. LD 1541 – “An Act to Support and Improve Municipal Recycling Programs and Save Taxpayer Money” – requires that companies using certain kinds of packaging materials cover the recycling costs of those materials.¹³³



Students sort their waste at a University of California Irvine sustainability event. Composting and recycling should be mandatory, less expensive than garbage disposal and available everywhere there are trash services – at home, school, work and in public.

It doesn't have to be this way.

America can create a circular material economy that moves towards producing zero waste.

The Zero Waste International Alliance, which in 2004 established a peer-reviewed, internationally accepted definition of zero waste to help guide businesses, institutions and communities in creating zero-waste goals, currently defines zero waste simply as “the conservation of all resources by means of responsible production, consumption, reuse, and recovery of products, packaging, and materials without burning and with no

discharges to land, water, or air that threaten the environment or human health.”¹³⁴

This goal can be achieved by replacing the wasteful linear material economy with a circular, or closed-loop, economic system. In this system, less would be consumed, products would be built to last and be easy to repair and, once they fulfilled their original purpose, would be easily reused, recycled or composted, eliminating the need for harmful landfills and incinerators. Then, new products would be made using the reused and recycled materials, replacing the need for harmful and wasteful extraction processes.

Steps to achieving a zero-waste system

The following steps can help create a zero-waste economy and can be promoted through a variety of policies and programs at the local, state and federal levels.

1. Set a goal to achieve zero waste.

A zero-waste goal is a critical step in driving the adoption of policies and practices that can achieve that aim. It is not enough to set goals to increase recycling and composting rates. To achieve zero waste, products will need to be made using reused and recycled materials, be built to last, and be easy to repair, reuse, recycle or compost. To make that possible, governments will need to adopt strong policies and provide financial and other support for waste reduction programs, reuse programs, research and infrastructure.

2. Require producers to take responsibility for their products during their entire life cycle.

Producers are usually not responsible for their products once they are purchased or their warranty runs out, so they have no financial incentives to use less packaging, to build products to last, or to make their products or packaging easy to repair, reuse, recycle, or compost.

Producers should be required to fund the collection and recycling of hard-to-recycle products after their useful lives. This will encourage them to improve the design of their products to be easily reusable, repairable, recyclable or compostable, and will increase the recycling rates of difficult-to-recycle products.

Product stewardship laws already exist across the country, and are effective at making manufacturers responsible for the collection and disposal of specific hard-to-recycle or hazardous materials, such as batteries, carpets or paint. More than 115

producer responsibility laws covering over a dozen types of products exist across the U.S.¹³⁵

Producer responsibility programs can be particularly useful in collecting, recycling and reimagining paper and packaging products (PPP). For over a decade, British Columbia has been running a successful program that holds producers responsible for managing several product waste streams, including paper and packaging waste. In 2019, the program recovered 78% of eligible material and recycled 90% of it.¹³⁶ These programs also spur producers, who are required to pay for the collection of their products, to innovate new containers and packaging that are easier to recycle and use fewer resources. Producer responsibility programs for PPP dramatically increase recycling rates by providing sustainable funding that enables equitable collection of materials for all residents in a jurisdiction and by streamlining the materials that are collected for recycling. Further, many producer responsibility programs charge producers by weight for the packaging they bring to market and charge more for materials that are harder to recycle. These charges can encourage producers to reduce their packaging and to use more environmentally friendly materials. As of July 2021, Maine became the first state in the U.S. to pass a law establishing producer responsibility for PPP.¹³⁷

In 2021, U.S. Rep. Alan Lowenthal and U.S. Sen. Jeff Merkley (re)introduced the Break Free From Plastic Pollution Act in Congress, an ambitious set of policies that includes, among other reforms, a ban on several single-use plastic items, a national bottle bill, a pause on new permits for plastic production and chemical recycling facilities, and a nationwide producer responsibility program for packaging.¹³⁸ Individually, each of these measures would meaningfully reduce the amount of unwanted waste

and pollution; taken together, the bill would upend our extractive, one-way waste system and greatly improve the sustainability of all sectors of society.

3. Price goods to reflect the environmental and public health impacts of their production.

The price of goods often does not reflect the impact of their production on the environment or public health. This has led to the proliferation of cheap goods that have serious environmental and public health impacts that society must ultimately pay for.

If products were priced to reflect the environmental and public health impacts of their production, such as the social costs of greenhouse gas emissions or other forms of pollution, consumers and businesses could make more informed purchases, which would reduce the amount of material needlessly thrown out. This would also encourage the development of safer and more environmentally friendly products, lowering the societal costs of environmental and public health impacts. There are clearly

opportunities for technological innovation in the materials we regularly interact with, one example being the growing variety of certified compostable foodware – though infrastructure for collecting and managing compostables has so far lagged behind.

4. Make recycling and composting mandatory, universally accessible and less expensive than garbage disposal.

Mandatory recycling and composting laws are among the most effective ways to reduce waste. Through these laws, residents, businesses and institutions are required to recycle and compost all appropriate materials. The burning of plastics or any waste for energy recovery should not be considered recycling.

To enact these laws, recycling and composting services must be made available everywhere there are garbage disposal services – at home, at work and in public. The state of Vermont, for example, now requires that publicly owned spaces provide recycling bins next to trash bins as part of its Universal Recycling Law.¹³⁹

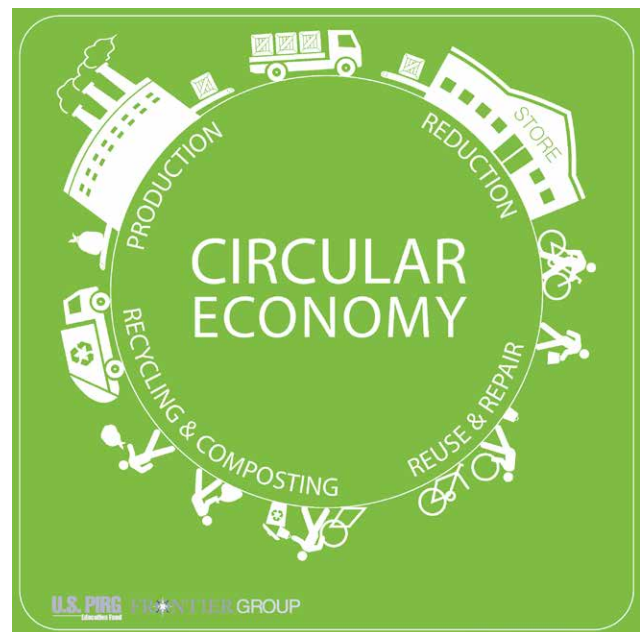
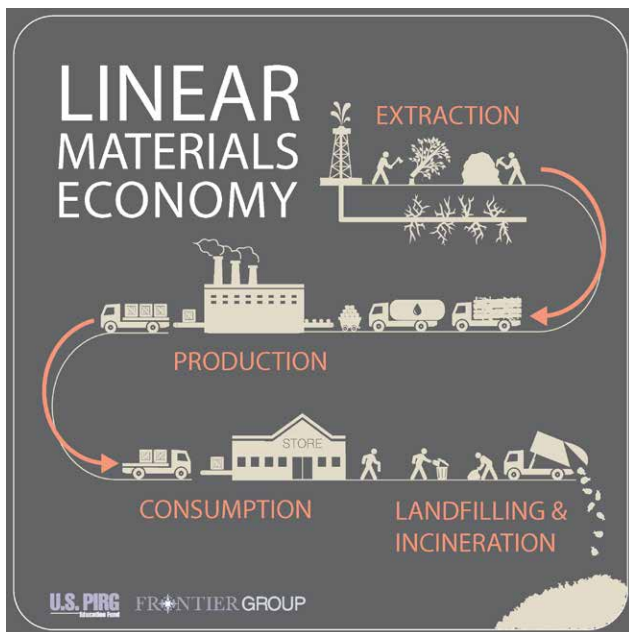


Figure 4. Material economic systems—linear versus circular

The success of mandatory recycling and composting programs depends on public education. For instance, in implementing its Universal Recycling Law, Vermont has established an education program in public schools that provides support and materials for teachers, such as sample lesson plans.¹⁴⁰ This program aims to make recycling and composting second nature for children, so that they will influence their families at home and carry these behaviors into adulthood.

Mandatory recycling and composting laws need to involve a system of accountability to be effective. In some places, waste haulers can be fined for continually dropping off excessive quantities of unrecyclable garbage in their recycling and composting loads and vice versa. Residents, businesses and institutions can also be issued warnings and fines when they do not sort their waste properly.

To further incentivize consumers to reduce the amount of garbage they produce, communities should ensure that it is more affordable to recycle and compost than to throw materials away. In many communities, garbage is collected for free or at a flat “all you can throw” rate, giving consumers no incentive to reduce the amount of waste they produce and throw away.

Pay as you throw (PAYT), also known as Saving Money and Reducing Trash (SMART) programs incentivize consumers to waste less and to recycle and compost more. PAYT is an effective policy tool that uses a modest price signal to encourage consumers to more carefully consider the waste they produce. 9,000 communities across the U.S. have some version of PAYT. One study of 20 Maine communities found PAYT programs generated 45% less trash and had a 62% higher recycling rate.¹⁴¹ These programs should be implemented everywhere and fees should be sufficient to incentivize composting and recycling.

There are other policies that can incentivize recycling and composting. Bottle bills, for instance, tack a small deposit onto products that come in bottles or cans. If consumers return the bottles and cans to be reused and recycled, they receive the deposit back, providing a direct incentive to return the bottles and cans instead of throwing them away. In 2018, of the 10 states with the highest recycling rate for common containers and packaging materials, eight had bottle bills.¹⁴²

Furthermore, the recyclable material collected as a result of bottle bills is of higher quality because it is separated and does not get contaminated by other materials, thereby commanding higher value in the marketplace.¹⁴³ This is especially true for glass, which is easily contaminated in single-stream recycling collection.

5. Require goods to be built to last and easy to repair, reuse, recycle or compost.

To move toward zero waste, policymakers should encourage the production and sale of products that are built to last and easy to repair, reuse, recycle or compost.

When products do break, it should be easy and cost-effective to repair them rather than throw them out. Many products are intentionally or inadvertently made to be difficult or impossible to repair, so they must be replaced when they break.¹⁴⁴ It is also often cheaper to buy new products than to repair existing ones. Policies that require the manufacturers of certain products to warranty their goods for a substantial length of time could encourage the sale of higher-quality products that are less likely to be thrown away prematurely.

In addition, some manufacturers hold the rights to all of the tools, parts or software needed to fix their products – a situation that can make it difficult or prohibitively expensive for consumers to have prod-

ucts repaired. Policymakers should enact “Right to Repair” reforms to remove these barriers. These reforms require that information, parts and tools needed to repair products be made available to consumers. These reforms also expand consumers’ rights to adapt and modify products to extend their useful lives.

Electronics are becoming a notorious example of products that break quickly and are difficult to repair. Impossible-to-open products and a restricted supply of original replacement parts can lead to consumers choosing to replace rather than repair.¹⁴⁵ Properly recycling electronics to reuse the valuable elements within requires specialized recycling facilities, but these can be scarce or hard to find. This is problematic because electronics contain toxic substances that can find their way into our air and water if thrown out in the regular trash.

Many products, such as lightweight and mixed-material packaging, are difficult to recycle. To avoid this, lawmakers should set standards for products sold in the U.S. to be recyclable, repairable or compostable. The U.S. should also support research into new materials that are more recyclable or compostable, or less polluting, as well as new recycling applications for discarded materials.

Products should be clearly labeled in a way that facilitates recycling. Most plastic is labeled with what appears to be the universal recycling symbol: three “chasing arrows” forming a triangle, with a number between one and seven inside. Confusingly, this refers to the type of plastic, not its recyclability, a fact 92% of Americans don’t know.¹⁴⁶ Truthful labeling laws, which restrict misleading recycling claims or symbols, can help people avoid misplaced confidence in plastic recycling.

6. Ban the sale of single-use items that are not easily recyclable or compostable, including packaging, plastic bags and food service ware.

Packaging and containers make up 28% of the materials thrown out by homes and businesses in the U.S.¹⁴⁷ Producers should be required to limit the amount of packaging they use and to make all packaging easy to recycle or compost.

Policymakers should tax, limit or ban products with limited usefulness that will most likely end up as waste. Single-use plastic bags, for example, almost all end up as waste and often as litter in our communities and waterways. These items are used for mere moments and then take decades to centuries to break down, harming the environment and our health in the process. To stop this nonsensical cycle, eleven U.S. states and many cities have banned single-use plastic shopping bags.¹⁴⁸ Many other cities, counties and states in the U.S. have programs to tax or limit plastic bags or increase their recycling rates.¹⁴⁹

Many communities are also banning the sale of polystyrene, commonly referred to as “Styrofoam,” a particular brand name. These communities are banning polystyrene, or specific polystyrene products like take-out food containers and packing peanuts, because they are typically not recyclable, do not biodegrade, and create harmful litter. In Massachusetts alone, at least 47 cities and towns have restricted polystyrene.¹⁵⁰

Single-use plastic foodware products, which are used for minutes but last for centuries, should also be banned. This includes beverage containers, polystyrene and to-go boxes. The use of disposable food service ware – straws, coffee cups, plastic forks, to-go containers, napkins, paper towels, paper plates, solo cups, etc. – should be limited to products that are easily recyclable or compostable.

7. Invest in repair, reuse, recycling and composting facilities to support a circular economy.

During the 20th century, the practice of disposing of materials as waste became ingrained in the U.S. This has led to vast public and private investments in infrastructure to bury and burn waste. The practice of disposing of everything as waste – and the landfills and incinerators that facilitate the practice – needs to be seen as outdated and dangerous, and retired. To create a new system, in which all materials are conserved and reused indefinitely, the U.S. needs to commit to new infrastructure – diversion, sorting, recycling and composting facilities.

Programs that guarantee a consistent, high-quality stream of materials for reuse, recycling or composting facilities encourage the development of this type of infrastructure. For example, in Oregon, which has a bottle bill, producers collect and process all of their bottles within the U.S., creating clean raw material that insulates its recycling industry from the instability of the global market.¹⁵¹ Likewise, companies will look to build anaerobic digesters in states where large cities and institutions have committed to diverting organic materials to composting facilities.¹⁵²

Increased recycling and composting rates may not be enough to stimulate the construction of recycling and composting infrastructure initially, so the public sector may need to invest strategically in these facilities to aid in the transition to a zero-waste economy. Government infrastructure spending could include expanded curbside recycling and compost for residents, as well as systems to encourage reuse such as more dishwashers in schools and water fountains in public parks.

8. Require producers to use recycled and reused materials in new products, and encourage businesses and governments to set procurement standards for recycled materials.

Encouraging or requiring that new products be made using reused or recycled material helps create a market for those materials, which increases the cost-effectiveness of recycling collection and processing. One way to achieve this is to revise procurement policies at large and/or for public institutions like government agencies and universities. Procurement policies can require institutions to purchase products made with a certain quantity of recycled materials. For example, most state agencies are required to purchase copy paper containing recycled content, but most of these requirements could be significantly increased and extended to other products.¹⁵³ In September 2020, California passed a law requiring plastic beverage bottles be made with 25% post-consumer recycled plastic by 2025 and 50% by 2030.¹⁵⁴

9. As waste is eliminated, ensure that all remaining waste is disposed of safely.

It will take time to move toward a circular economy that produces zero waste. During that time, all discarded materials need to be disposed of safely.

To protect the environment and public health, goods that are hazardous during their production, use or disposal should be banned. Mercury, for example, which is toxic to humans, was common in batteries and thermostats until it was largely phased out by legislative bans.¹⁵⁵ There are substances that are still used in products that should also be banned in the U.S. For instance, the U.S. is one of the only industrialized nations that has not completely banned asbestos, which can cause lung cancer, mesothelioma and other chronic respiratory ailments.¹⁵⁶

U.S. chemical policy should be revised to reduce and ultimately eliminate the presence of toxics in household products. New substances are put on the market so quickly that safety precautions tend to lag behind. To address this, the European Union enacted a regulation called Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), which requires industries to study the risks associated with substances they use and to register that information in a central database, so that safety information is readily available.¹⁵⁷ This regulation also requires the most toxic substances to be phased out and replaced with safer alternatives.¹⁵⁸ The U.S. should enact similar regulations.

Policies can also be enacted to increase the reuse and recycling of hazardous materials. A federal act passed in 1996, for example, required manufacturers to make batteries easier to recycle to prevent them from being dumped into landfills where they can leach hazardous chemicals into the environment.¹⁵⁹ Policies such as this should be enacted for all hazardous materials.

The U.S. also needs to invest in improving overall hazardous waste management, which is regulated under the Resource Conservation and Recovery Act. The American Society of Civil Engineers gave U.S. hazardous waste infrastructure a D+ in 2021 and said that support is needed to develop new methods in hazardous waste management.¹⁶⁰

10. Oppose the construction, expansion and subsidization of landfills, incinerators and waste-to-fuel facilities marketed as “chemical recycling.”

To encourage the necessary transition to a zero-waste economy and to protect the environment and public health, local and state governments should oppose new or expanded landfills and incinerators.

The incineration industry markets waste-to-energy incinerators as renewable energy resources and solutions for America’s waste problem. Burning garbage, however, necessitates new materials be extracted to fuel the linear material system, a process that creates immense amounts of waste and pollution itself. Producing new materials also consumes far more energy than reuse and recycling.¹⁶¹

Waste-to-energy facilities also claim to incinerate trash safely and to produce less pollution with new technologies, but all are variations on combustion, gasification and pyrolysis, which cause very similar problems.¹⁶² Incineration facilities are also promoted as being superior to landfills, but the ash they produce ultimately ends up in landfills. Furthermore, incinerator ash is toxic and may leach into water supplies when it is dumped in toxic waste landfills.¹⁶³

Incinerators are rarely economical: The city of Harrisburg went bankrupt due to a \$360 million incinerator debt, and Detroit spent \$1.2 billion on its incinerator.¹⁶⁴ Because incinerators are so expensive, they often negotiate public subsidies and long-term contracts with municipalities that commit to provide a steady volume of waste, often for 20 to 30 years.¹⁶⁵ Cities can be penalized if they don’t provide enough trash: In 2019, Baltimore was sued for over \$32 million for failing to deliver enough waste to meet its contract.¹⁶⁶ In November 2020, the city gave the incinerator a 10-year contract extension in an effort to settle the case.¹⁶⁷

The need for a continual waste stream is at odds with efforts to reduce waste. Incinerators also need waste that produces the most energy by weight and volume to be economical. Plastics are highly valued in an incinerator because they have a high energy value, so this creates another disincentive for recycling and plastic reduction.¹⁶⁸ Incineration is not a solution to the U.S. waste problem, it is just another form of the same system.

Waste-to-fuel schemes that turn plastic into fossil fuels are a new form of that system. Although the industry labels the process “chemical recycling,” in reality it is an endpoint of the linear, extractive economy for plastics. “Waste-to-fuel” creates highly toxic air pollution and drives demand for plastic waste.¹⁶⁹ “Waste-to-plastic,” an even newer concept of chemically breaking down plastic to form new plastic products, is technologically unproven at scale and there are no commercially operating facilities in the U.S. that create new plastic materials in this way.¹⁷⁰ All these projects, which incentivize the creation of more waste, should

be actively opposed, not encouraged and subsidized.

Towns, cities, states and the U.S. as a whole should adopt these recommendations and follow the leadership of the communities shifting to a circular economy. We have the technology and know-how to make this transformation – to conserve natural resources and energy, to cut pollution and to protect our health, environment and future. No longer can we outsource our waste and pretend that it is out of mind. Now is the time to commit to making a zero waste America reality.

Notes

1. Niall Smith, Verisk Maplecroft, *US Tops List of Countries Fueling the Waste Crisis*, 2 July 2019, available at <https://www.maplecroft.com/insights/analysis/us-tops-list-of-countries-fuelling-the-mounting-waste-crisis/>.

2. Environmental Protection Agency, *Advancing Sustainable Materials Management: 2018 Fact Sheet*, December 2020, available at https://www.epa.gov/sites/production/files/2021-01/documents/2018_ff_fact_sheet_dec_2020_fnl_508.pdf.

3. Ibid., p.2.

4. Ibid., p.3.

5. EPA, *Plastics: Material-Specific Data*, 5 January 2021, archived at <http://web.archive.org/web/20210301133515/https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/plastics-material-specific-data>.

6. The U.S. discarded a record 35,680,000 tons of plastic in 2018: EPA, *Plastics: Material-Specific Data*, 5 January 2021, archived at <http://web.archive.org/web/20210301133515/https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/plastics-material-specific-data>; 32.7 lbs/cubic yard of plastic waste, average of mixed PET, HDPE, bottles and containers: EPA, *Volume-to-Weight Conversion Factors*, April 2016, archived at http://web.archive.org/web/20201103175236/https://www.epa.gov/sites/production/files/2016-04/documents/volume_to_weight_conversion_factors_memorandum_04192016_508fnl.pdf; 3.85 million cubic yards in AT&T Stadium, 104 million cubic feet: DesignBuild-Network, *Cowboys Stadium*, archived 9 January 2021 at <http://web.archive.org/>

[web/20200109212523/https://www.designbuild-network.com/projects/cowboysstadium/](http://web.archive.org/web/20200109212523/https://www.designbuild-network.com/projects/cowboysstadium/).

7. Max Liboiron, Northeastern University Social Science Environmental Health Research Institute, “Modern waste as strategy,” *Losquadero: Explorations in Space and Society*, 29, September 2013, archived at <http://web.archive.org/web/20180421124239/http://www.losquadero.professionaldreamers.net/wp-content/uploads/2013/09/losquadero29.pdf>.

8. See note 2.

9. Ibid.

10. Ibid.

11. EPA, *Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM) Background Chapters*, November 2020, p.1-1, available at https://www.epa.gov/sites/production/files/2020-12/documents/warm_background_v15_10-29-2020.pdf.

12. Mercury: Global Alliance for Incinerator Alternatives, *Pollution and Health Impacts of Waste-to-Energy Incineration*, 2019, available at https://www.no-burn.org/wp-content/uploads/Pollution-Health_final-Nov-14-2019.pdf; Dioxins: Natalija Marinković et al., “Dioxins and human toxicity,” *Archives of Industrial Hygiene and Toxicology*, 61(4):445-453, doi: 10.2478/10004-1254-61-2010-2024, 2010.

13. Kirstie Pecci, Conservation Law Foundation, *All Landfills Leak, and our Health and Environment Pay the Toxic Price*, 23 July 2018, available at <https://www.clf.org/blog/all-landfills-leak-and-our-health-and-environment-pay-the-toxic-price/>.

14. 16.5 tons, converted from 15 metric tons: Andrew Forrest et al., "Eliminating plastic pollution: How a voluntary contribution from industry will drive the circular plastics economy," *Frontiers in Marine Science*, 6(627): figure 1, doi: 10.3389/fmars.2019.00627, September 2019.
15. Laura Parker, "Eight million tons of plastic dumped in ocean every year," *National Geographic*, 13 February 2015; S.C. Gall and R.C. Thompson, "The Impact of Debris on Marine Life," *Marine Pollution Bulletin*, 92(1-2):170-179, 15 March 2015; World Economic Forum, *The New Plastics Economy, January 2016*, available at http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf.
16. S.C. Gall and R.C. Thompson, "The impact of debris on marine life," *Marine Pollution Bulletin*, 92(1-2):170-179, 15 March 2015.
17. The U.S. landfilled and incinerated 21.42 million tons of paper and paperboard in 2018: Environmental Protection Agency, *Advancing Sustainable Materials Management: 2018 Fact Sheet*, December 2020, available at https://www.epa.gov/sites/production/files/2021-01/documents/2018_ff_fact_sheet_dec_2020_fnl_508.pdf; 15 – 17 mature trees produce 1 ton of paper: U.S. EPA, *Environmental Factoids*, 30 March 2016, archived at <http://web.archive.org/web/20170914152124/https://archive.epa.gov/epawaste/conservation/smm/wastewise/web/html/factoid.html>. Estimate given here is a conservative estimate based on 15 trees per ton.
18. Chris Mooney, "The staggering environmental footprint of all the food that we just throw in the trash," *Washington Post*, 18 April 2018, available at <https://www.washingtonpost.com/news/energy-environment/wp/2018/04/18/americans-waste-about-a-quarter-of-the-food-they-buy-and-the-environmental-consequences-are-staggering/>.
19. Eric Roper and Kristen Leigh Painter, "Lobbying group fights surge of bills targeting plastic packaging," *Minneapolis Star-Tribune*, 24 February 2020, available at <https://www.startribune.com/lobbying-group-fights-insurgence-of-bills-targeting-plastic-packaging/568127282/>.
20. See note 2.
21. Maria Rachal, "Composting infrastructure coalition seeks hundreds of millions for federal grants, loans," *Waste Dive*, 11 May 2021, available at <https://www.wastedive.com/news/us-composting-infrastructure-coalition-biden-federal/599946/>.
22. See note 2.
23. See note 2.
24. See note 2.
25. Sarah Morath, The Regulatory Review, *The Match Between COVID-19 and Plastic Bans*, 11 May 2020, available at <https://www.theregview.org/2020/05/11/morath-match-between-covid-19-plastic-bags/>; New Jersey: Scott Fallon, NorthJersey.com, *NJ Bag Ban: Gov. Phil Murphy Signs Nation's Most Stringent Bag, Styrofoam Ban into Law*, 4 November 2020, available at <https://www.northjersey.com/story/news/environment/2020/11/04/nj-bag-ban-signed-gov-phil-murphy-toughest-plastic-styrofoam-polystyrene-ban/6134262002/>; Colorado: Alex Burness, Denver Post, *Colorado Will Ban Single-Use Plastic Bags and Polystyrene, Create Bag Fees*, 6 July 2021, available at <https://www.denverpost.com/2021/07/06/colorado-plastic-bag-ban-fee-polystyrene>; Oceana, *Washington State Bans Polystyrene Foam, Limits Single-Use Plastic at Restaurants* (press release), 17 May 2021, available at <https://usa.oceana.org/press-releases/washington-state-bans-polystyrene-foam-limits-single-use-plastic-restaurants>.
26. Vermont Department of Environmental Conservation, *Universal Recycling Food Scrap Ban Guidance*, June 2020, available at <https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/Universal-Recycling/Food-Scrap-Ban-Guidance.pdf>.
27. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, "Waste management in Germany," March 2018, available at https://www.bmu.de/fileadmin/Daten_BMU/Pool/Broschueren/abfallwirtschaft_2018_en_bf.pdf.

28. Maine Revised Statute tit. 38, § 2146 (2021), archived at <http://web.archive.org/web/20210714152828/http://www.mainelegislature.org/legis/bills/getPDF.asp?paper=HP1146&item=11&snum=130>.
29. See note 2.
30. Amy Brooks, Shunli Wang, and Jenna Jambeck, “The Chinese import ban and its impact on global plastic waste trade,” *Science Advances* 4(6): table 1, doi: 10.1126/sciadv.aat0131, 20 Jun 2018.
31. Christopher Joyce, “Where will your plastic trash go now that China doesn’t want it?,” *NPR*, 13 March 2019, available at <https://www.npr.org/sections/goatsandsoda/2019/03/13/702501726/where-will-your-plastic-trash-go-now-that-china-doesnt-want-it>.
32. Jason Margolis, “Mountains of US recycling pile up as China restricts imports,” *PRI*, 1 January 2018, available at <https://www.pri.org/stories/2018-01-01/mountains-us-recycling-pile-china-restricts-imports>.
33. Muyu Xu and David Stanway, “China plans to cut waste imports to zero by next year: official,” *Reuters*, 28 March 2019, available at <https://www.reuters.com/article/us-china-waste-imports/china-plans-to-cut-waste-imports-to-zero-by-next-year-official-idUSKCN1R90AQ>.
34. See note 31.
35. *Ibid.*
36. Saabira Chaudhuri, “Recycling rethink: What to do with trash now that China won’t take it,” *Wall Street Journal*, 19 December 2019, available at <https://www.wsj.com/articles/recycling-rethink-what-to-do-with-trash-now-china-wont-take-it-11576776536>.
37. Leslie Hook and John Reed, “Why the world’s recycling system stopped working,” *Financial Times*, 25 October 2018, available at <https://www.ft.com/content/360e2524-d71a-11e8-a854-33d6f82e62f8>.
38. Frank Kummer, “At least half of Philly’s recycling goes straight to an incinerator,” *The Philadelphia Inquirer*, 29 January 2019, archived at <http://web.archive.org/web/20210608224505/https://www.inquirer.com/science/climate/recycling-costs-philadelphia-incinerator-waste-to-energy-plant-20190125.html>.
39. Alana Semuels, “Is this the end of recycling?,” *The Atlantic*, 5 March 2019, <https://www.theatlantic.com/technology/archive/2019/03/china-has-stopped-accepting-our-trash/584131/>.
40. E.A. Crunden, “How many curbside recycling programs have been cut?,” *Waste Dive*, 19 February 2020, available at <https://www.wastedive.com/news/curbside-recycling-cancellation-tracker/569250/>.
41. San Francisco Department of the Environment, *Compostable Bags and Food Service Ware*, 2020, archived at <http://web.archive.org/web/20210421215523/https://sfenvironment.org/business-recycling-and-composting/overview/compostable-bags-and-food-service-ware>.
42. See note 25.
43. See note 27.
44. See note 28.
45. See note 1.
46. See note 7.
47. EPA, *Guide for Industrial Waste Management*, March 2016, available at <https://www.epa.gov/sites/production/files/2016-03/documents/industrial-waste-guide.pdf>.
48. Jadwiga Szczepańska and Irena Twardowska, Science Direct, *Mining Waste*, 2004, archived 26 March 2021 at <http://web.archive.org/web/20210326043713/https://www.sciencedirect.com/topics/earth-and-planetary-sciences/mining-waste>.
49. EPA, *Construction and Demolition Debris: Material-Specific Data*, 28 October 2020, archived at <http://web.archive.org/web/20210322162043/https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/construction-and-demolition-debris-material>.

50. EPA, *National Overview: Facts and Figures on Materials, Wastes and Recycling*, 28 January 2021, archived at <http://web.archive.org/web/20210304173859/https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials>.

51. EPA, *Management of Exploration, Development and Production Wastes*, April 2019, p. 3-11, archived at https://www.epa.gov/sites/production/files/2019-04/documents/management_of_exploration_development_and_production_wastes_4-23-19.pdf. Solid waste was taken to include, among other waste types, Stimulation/Workover Fluids and Drilling Fluids/Mud.

52. EPA, *"Quantity of RCRA Hazardous Waste Generated and Managed*, 12 September 2019, available at <https://cfpub.epa.gov/roe/indicator.cfm?i=54>.

53. See note 2.

54. Ibid.

55. Ibid.

56. Ibid.

57. Ibid.

58. Landfills: EPA, *Landfill Methane Outreach Program*, 14 July 2021, available at <https://www.epa.gov/lmop/landfill-technical-data>; Incinerators: EPA, *Energy Recovery from the Combustion of Municipal Solid Waste (MSW)*, 31 July 2020, archived at <http://web.archive.org/web/20210311215514/https://www.epa.gov/smm/energy-recovery-combustion-municipal-solid-waste-msw>.

59. See note 2.

60. Maggie Koerth, "The era of easy recycling may be coming to an end," *FiveThirtyEight*, 10 January 2019, available at <https://fivethirtyeight.com/features/the-era-of-easy-recycling-may-be-coming-to-an-end/>.

61. John Culbertson, MSW Consultants, *Measuring Composition and Contamination at the MRF*, 31 October 2018, p.15, available at https://nerc.org/documents/conferences/Fall%202018%20Conference/Measuring%20Composition%20and%20Contamination%20at%20the%20MRF_John%20Culbertson.pdf.

62. 6.1 million: EPA, *Reducing the Impact of Wasted Food by Feeding the Soil and Composting*, 29 October 2020, available at <https://www.epa.gov/sustainable-management-food/reducing-impact-wasted-food-feeding-soil-and-composting>; 4.1%: EPA, *Advancing Sustainable Materials Management: 2018 Fact Sheet*, December 2020, available at https://www.epa.gov/sites/production/files/2021-01/documents/2018_ff_fact_sheet_dec_2020_fnl_508.pdf.

63. See note 2.

64. EPA, *Global Greenhouse Gas Emissions Data*, 25 March 2021, available at <https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data>.

65. See note 11.

66. EPA, *Sources of Greenhouse Gas Emissions*, 4 December 2020, available at <http://web.archive.org/web/20210724091444/https://www.epa.gov/ghgemissions/sources-greenhouse-gas--emissions>. Note that transportation and electricity production overlap with the waste system and are not directly comparable sectors.

67. EPA, *Source Reduction and Recycling: A Role in Preventing Global Climate Change*, 21 February 2016, archived at https://archive.epa.gov/region4/rcra/mgtoolkit/web/pdf/climate_change_fact_sheet.pdf.

68. See note 2, p.14.

69. Brenda Platt at al., Institute for Local Self-Reliance, *Stop Trashing the Climate*, June 2008, p.2, archived at http://web.archive.org/web/20210506224752/http://www.ilsr.org/wp-content/uploads/2008/06/stoptrashingthecolimate_exsum_lowres.pdf.

70. Eighty-six times more potent: Gayathri Vaidyanathan, "How bad of a greenhouse gas is methane?," *Scientific American*, 22 December 2015, archived at <https://web.archive.org/web/20210711003631/https://www.scientificamerican.com/article/how-bad-of-a-greenhouse-gas-is-methane/#>. See also 20-year Global Warming Potential of 84-87: EPA, *Understanding Global Warming Potentials*, 9 September 2020, available at <https://www.epa.gov/ghgemissions/understanding-global-warming-potentials>; EPA, *Advancing Sustainable Materials Management: 2018 Fact Sheet*, December 2020, available at https://www.epa.gov/sites/production/files/2021-01/documents/2018_ff_fact_sheet_dec_2020_fnl_508.pdf; Tom Szaky, *Outsmart Waste: The Modern Idea of Garbage and How to Think Our Way Out of It*, (San Francisco: Berrett-Koehler Publishers, 2014).

71. EPA, *Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019*, February 2021, p.7-6, available at <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks>.

72. Institute of Scrap Recycling Industries, *Overall Industry Factsheet 2018*, available at https://www.isri.org/docs/default-source/commodities/overall-industry-fact-sheet_2018.pdf?sfvrsn=2971a413_18.

73. New York Department of Health, *Important Things to Know About Landfill Gas*, August 2012, archived at http://web.archive.org/web/20170918170805/https://www.health.ny.gov/environmental/outdoors/air/landfill_gas.htm.

74. U.S. Center for Disease Control and Prevention, Agency for Toxic Substances & Disease Registry (ATSDR), *Toxic Substances Portal - Hydrogen Sulfide Carbonyl Sulfide*, 21 October 2014, archived at <http://web.archive.org/web/20180126191024/https://www.atsdr.cdc.gov/mmg/mmg.asp?id=385&tid=67>.

75. Ibid.

76. CDC, *Dioxins, Furans and Dioxin-Like Polychlorinated Biphenyls Factsheet*, 7 April 2017, archived at <http://web.archive.org/>

[save/https://www.cdc.gov/biomonitoring/DioxinLikeChemicals_FactSheet.html](https://www.cdc.gov/biomonitoring/DioxinLikeChemicals_FactSheet.html).

77. Global Alliance for Incinerator Alternatives, *An Industry Blowing Smoke: 10 Reasons Why Gasification, Pyrolysis & Plasma Incineration Are Not "Green Solutions,"* June 2009, available at <https://www.no-burn.org/wp-content/uploads/BlowingSmokeReport.pdf>.

78. Andrew Rollinson and Jumoke Oladejo, GAIA, *Chemical Recycling: Status, Sustainability, and Environmental Impacts*, June 2020, p.24, available at https://www.breakfreefromplastic.org/wp-content/uploads/2020/06/CR-Technical-Assessment_June-2020.pdf.

79. Ibid.

80. Ibid.

81. Maurizio Crippa et al., European Commission, *A Circular Economy for Plastics*, January 2019, p.144, available at https://www.hbm4eu.eu/wp-content/uploads/2019/03/2019_RI_Report_A-circular-economy-for-plastics.pdf.

82. Denise Patel et al., GAIA, *All Talk and No Recycling: An Investigation of the U.S. "Chemical Recycling" Industry*, July 2020, p.9, available at https://www.no-burn.org/wp-content/uploads/All-Talk-and-No-Recycling_July-28.pdf.

83. Ioannis Kalargaris, Guohong Tian, and SaiGu, "The utilisation of oils produced from plastic waste at different pyrolysis temperatures in a DI diesel engine," *Energy*, 131:171-175, doi: <https://doi.org/10.1016/j.energy.2017.05.024>, 15 July 2017.

84. See note 13.

85. U.S. Geological Survey, *Landfill Leachate Released to Wastewater Treatment Plants and other Environmental Pathways Contains a Mixture of Contaminants including Pharmaceuticals*, 10 January 2017, archived at http://web.archive.org/web/20180126185120/https://toxics.usgs.gov/highlights/2015-11-13-leachate_pathways.html.

86. Justin Nobel, "America's radioactive secret," *Rolling Stone*, 21 January 2020, available at <https://www.rollingstone.com/politics/politics-features/oil-gas-fracking-radioactive-investigation-937389/>.

87. See note 58.

88. City of Lewisville, *Lewisville Reaches Agreement in Federal Lawsuit Against Camelot Landfill*, 10 March 2015, archived at <http://web.archive.org/web/20171020151109/https://www.cityoflewisville.com/Home/Components/News/News/1234/710?arch=1&npage=26>.

89. City of Lewisville, *Lewisville Reaches Agreement in Federal Lawsuit Against Camelot Landfill*, 10 March 2015, archived at <http://web.archive.org/web/20171020151109/https://www.cityoflewisville.com/Home/Components/News/News/1234/710?arch=1&npage=26>; ReedGroup, *MDGuidelines, Toxic Effects, Chlorinated Hydrocarbon Solvents*, archived at <http://web.archive.org/web/20180214011409/http://www.mdguidelines.com/toxic-effects-chlorinated-hydrocarbon-solvents>.

90. Ryan Van Velzer, "Louisville hazardous waste site still leaking pollution into Ohio River," *WPFL*, 26 April 2019, available at <https://wfpl.org/louisville-hazardous-waste-site-still-leaking-pollution-into-ohio-river/>; 15 ppb: EPA, *Basic Information about Lead in Drinking Water*, 9 December 2020, available at <https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-lead-drinking-water#regs>.

91. 16.5 tons derived from 15 tonnes: Andrew Forrest et al., "Eliminating plastic pollution: How a voluntary contribution from industry will drive the circular plastics economy," *Frontiers in Marine Science*, 6(627), doi: 10.3389/fmars.2019.00627, figure 1, September 2019; 2040: Pew Charitable Trusts, *Breaking the Plastic Wave*, July 2020, available at https://www.pewtrusts.org/-/media/assets/2020/07/breakingtheplasticwave_report.pdf.

92. Pew Charitable Trusts, *Breaking the Plastic Wave*, July 2020, p.25, available at https://www.pewtrusts.org/-/media/assets/2020/07/breakingtheplasticwave_report.pdf.

93. Marian Lu, "Great Pacific Garbage Patch now three times the size of France," *CNN*, 23 March 2018, available at <https://www.cnn.com/2018/03/23/world/plastic-great-pacific-garbage-patch-intl>.

94. Marcus Erikson et al., "Plastic pollution in the world's oceans: More than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea," *PLoS One*, 9(12): doi: 10.1371/journal.pone.0111913, 10 December 2014.

95. See note 16.

96. Ibid.

97. Sarah Knapton, "Seafood eaters ingest up to 11,000 tiny pieces of plastic every year, study shows," *The Telegraph*, 24 January 2017, available at <https://www.telegraph.co.uk/science/2017/01/24/seafood-eaters-ingest-11000-tiny-pieces-plastic-every-year-study/>.

98. Wijnand de Wit and Nathan Bigaud, World Wildlife Fund, *No Plastic in Nature: Assessing Plastic Ingestion from Nature to People*, June 2019, available via Analysis and Policy Observatory, available at <https://apo.org.au/node/244456>.

99. A. Butterworth, I. Clegg, and C. Bass, London: World Society for the Protection of Animals, *Untangled – Marine Debris: A Global Picture of The Impact on Animal Welfare and of Animal-Focused Solutions*, July 2012, p.34, available at https://www.researchgate.net/publication/263444260_Marine_debris_a_global_picture_of_the_impact_on_animal_welfare_and_of_animal-focused_solutions.

100. Ibid.

101. See note 98.

102. Sources: Plastics information is from the American Chemistry Council, the National Association for PET Container Resources and The Association of Plastic Recyclers. Available at U.S. Environmental Protection Agency, *Facts and Figures about Materials, Waste and Recycling: Plastics: Material-Specific Data*, 26 May 2021, archived at <https://web.archive.org/web/20210630183558/https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/plastics-material-specific-data>.
103. See note 5.
104. See note 17.
105. Natural Resources Defense Council, *Pandora's Box: Clearcutting in the Canadian Boreal Unleashes Millions of Tons of Previously Uncounted Carbon Dioxide Emissions*, March 2018, available at <https://www.nrdc.org/sites/default/files/pandoras-box-clearcutting-boreal-carbon-dioxide-emissions-ip.pdf>.
106. See note 18.
107. Brian Lipinski, World Resources Institute, *By the Numbers: Reducing Food Loss and Waste*, 5 June 2013.
108. Ibid.
109. Jean C. Buzby, Hodan Wells, and Jeffrey Hyman, "The estimated amount, value, and calories of postharvest food losses at the retail and consumer levels in the United States," *U.S. Department of Agriculture, Economic Research Service*, February 2014.
110. See note 2.
111. Jacob Duer, "The plastic pandemic is only getting worse during COVID-19," *World Economic Forum*, 1 July 2020, available at <https://www.weforum.org/agenda/2020/07/plastic-waste-management-covid19-ppe/>.
112. Danny McDonald, "COVID-19 has changed everything, even Boston's trash. Here's how," *Boston Globe*, 13 December 2020, available at <https://www.bostonglobe.com/2020/12/13/metro/covid-19-has-changed-everything-even-bostons-trash-heres-how/>.
113. Joe Brock, "The plastic pandemic: COVID-19 trashed the recycling dream," *Reuters*, 5 October 2020, available at <https://www.reuters.com/investigates/special-report/health-coronavirus-plastic-recycling/>.
114. Alana Semuels, "'Garbage freaking everywhere' as Americans venture outdoors after a year of lockdowns," *Time*, 26 March 2021, available at <https://time.com/5949983/trash-pandemic/>.
115. Annie Ropeik, New Hampshire Public Radio, *As N.H. Continues COVID Ban On Reusable Bags, Some Say Politics Is Trumping Science*, 21 July 2020, available at <https://www.nhpr.org/climate-change/2020-07-21/as-n-h-continues-covid-ban-on-reusable-bags-some-say-politics-is-trumping-science>.
116. Vaclav Smil, Institute of Electrical and Electronics Engineers, *Electricity Prices: A Changing Bargain*, February 2020, available at <http://vaclavsmil.com/wp-content/uploads/2020/04/61.ELPRICES.pdf>.
117. Daniel E. Sullivan, John L. Sznoppek, and Lorie A. Wagner, U.S. Department of the Interior and USGS, *20th Century U.S. Mineral Prices Decline in Constant Dollars*, 2000, estimated from trendline in figure 2, available at <https://pubs.usgs.gov/of/2000/of00-389/of00-389.pdf>.
118. U.S. Census Bureau, *Statistical Abstract of the United States: 1999, 20th Century Statistics*, p.877, available at <https://www.census.gov/prod/99pubs/99statab/sec31.pdf>.
119. Lloyd Stouffer, *Plastics Packaging: Today and Tomorrow*, speech to the Society of the Plastics Industry, November 1963, available at <https://discardstudies.com/wp-content/uploads/2014/07/stoffer-plastics-packaging-today-and-tomorrow-1963.pdf>.
120. Adam Hadhazy, "Here's the truth about the 'planned obsolescence' of tech," *BBC*, 12 June 2016, available at <https://www.bbc.com/future/article/20160612-heres-the-truth-about-the-planned-obsolescence-of-tech>.

121. Food and Drug Administration, *Food Loss and Waste*, 23 February 2021, archived at <http://web.archive.org/web/20210305142905/https://www.fda.gov/food/consumers/food-loss-and-waste>.
122. Jonathan Church and Ken Stewart, U.S. Department of Labor, Bureau of Labor Statistics, "Average food prices: A snapshot of how much has changed over a century," *Prices & Spending*, 2(6), February 2013; U.S. DOL, Bureau of Labor Statistics, *CPI Inflation Calculator*, available at <https://data.bls.gov/cgi-bin/cpicalc.pl>.
123. Beth Gardiner, "Food industry goes beyond looks to fight waste," *New York Times*, 24 October 2016, archived at <http://web.archive.org/web/20210503220647/https://www.nytimes.com/2016/10/24/business/food-industry-goes-beyond-looks-to-fight-waste.html>.
124. Dr. Jean Buzby, USDA, *Why Should we Care About Food Waste?*, archived 13 August 2021 at <http://web.archive.org/web/20210813165638/https://www.usda.gov/foodlossandwaste/why>.
125. Matthew Gault, "Half the country is now considering right to repair laws," *Vice*, 15 March 2021, archived at <https://web.archive.org/web/20210630190237/https://www.vice.com/en/article/z3vavw/half-the-country-is-now-considering-right-to-repair-laws>. See also USPIRG, "Stand up for repair," archived at <http://web.archive.org/web/20210430162157/https://uspirg.org/feature/usp/stand-repair>.
126. Bottle Bill Resource Guide, *Bottle Bill Opponents*, archived 15 November 2017 at <http://web.archive.org/web/20171115194022/http://www.bottlebill.org/about/opponents.htm>; Lydia O'Connor, "Why the landmark plastic bag ban might be put on hold," *Huffpost*, 30 December 2014.
127. See note 27.
128. Agnes Bünemann et al., *PREVENT Waste Alliance*, Germany, 21 September 2020, available at <https://prevent-waste.net/wp-content/uploads/2020/09/Germany.pdf>.
129. Ibid.
130. See note 27.
131. Nina Nakajima and Willem H. Vanderburg, "A description and analysis of the German packaging take-back system," *Bulletin of Science, Technology & Society* 26(6): doi: 10.1177/0270467606295193, December 2006.
132. Megan Quinn, "2021 could be year for packaging EPR, nearly a dozen state bills in play," *Waste Dive*, 12 February 2021, available at <https://www.wastedive.com/news/2021-state-extended-producer-responsibility-recycling/594873/>.
133. See note 28.
134. Zero Waste International Alliance, *Zero Waste Definition*, 20 December 2018, archived at <http://web.archive.org/web/20210707170507/https://zwia.org/zero-waste-definition/>.
135. Product Stewardship Institute, *Framework Legislation for Extended Producer Responsibility Programs*, 2020, available at <https://www.productstewardship.us/page/Framework-Legislation>.
136. Recycle BC, *2019 Annual Report*, 2019, available at https://www2.gov.bc.ca/assets/gov/environment/waste-management/recycling/recycle/paper-package/2019_recyclebc_annual_report.pdf.
137. See note 28.
138. Megan Quinn, "Break Free From Plastic Pollution Act reintroduced, plastics industry ramps up opposition," *Waste Dive*, 25 March 2021, available at <https://www.wastedive.com/news/break-free-from-plastic-pollution-act-reintroduced/597338/>.
139. Vermont DEC, *Vermont's Universal Recycling Law: Status Report*, January 2019, available at <https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/Universal-Recycling/2019.Universal.Recycling.Status.Report.pdf>.

140. Vermont DEC, *Universal Recycling for Schools*, archived 28 April 2021 at <http://web.archive.org/web/20210428182329/https://dec.vermont.gov/waste-management/solid/universal-recycling/schools>.
141. WasteZero, WasteZero®, *Releases Report Analyzing the Impact of Pay-As-You-Throw Systems on Residential Trash in Southern Maine* (press release), 7 June 2018, archived at <http://web.archive.org/web/20201109025717/https://www.prnewswire.com/news-releases/wastezero-releases-report-analyzing-the-impact-of-pay-as-you-throw-systems-on-residential-trash-in-southern-maine-300661882.html>.
142. Top 10 states for recycling: Maine (72%), Vermont (62%), Massachusetts (55%), Oregon (55%), Connecticut (52%), New York (51%), Minnesota (49%), Michigan (48%), New Jersey (46%), and Iowa (44%). Minnesota and New Jersey are the only ones without bottle bills. Eunomia, *Measuring Packaging Recycling Rates Across the US*, 30 March 2021, archived at <https://web.archive.org/web/20210630193448/https://www.eunomia.co.uk/measuring-packaging-recycling-rates-across-the-us/>.
143. New York State Pollution Prevention Institute (NYSPP2I), “New York State Department of Environmental Conservation: Impact study of NYS bottle bill expansion,” 4 November 2019, available at http://www.dec.ny.gov/docs/materials_minerals_pdf/bottlebillstudy.pdf.
144. Nathan Proctor, U.S. PIRG Education Fund, *The Fix is In*, March 2020, available at https://uspig.org/sites/pirg/files/reports/The-Fix-Is-In/The_Fix_Is_In_March2020_USPEF.pdf.
145. Whitson Gordon, iFixit, *The Most Common Ways Manufacturers Prevent You From Repairing Your Devices*, 17 April 2019, available at <https://www.ifixit.com/News/15617/the-most-common-ways-manufacturers-prevent-you-from-repairing-your-devices>.
146. Consumer Brands Association, *Reduce. Reuse. Confuse.*, April 2019, p.6, available at https://consumerbrandsassociation.org/wp-content/uploads/2019/04/ConsumerBrands_ReduceReuseConfuse.pdf.
147. See note 2.
148. See note 25.
149. National Conference of State Legislatures, *State Plastic and Paper Bag Legislation*, 8 February 2021, archived at <http://web.archive.org/web/20210302215032/https://www.ncsl.org/research/environment-and-natural-resources/plastic-bag-legislation.aspx>.
150. MassGreen.org, *Polystyrene Legislation*, archived 22 March 2021 at <http://web.archive.org/web/20210322075314/http://www.massgreen.org/polystyrene-legislation.html>.
151. Moe Clark, “10 states use bottle deposits to boost recycling rates. Could it work for Colorado?,” *Colorado Sun*, 9 December 2019, available at <https://coloradosun.com/2019/12/09/bottle-deposit-bill-colorado-oregon-recycling/>.
152. Elizabeth Royte, “The compost king of New York,” *New York Times Magazine*, 15 February 2017, archived at <http://web.archive.org/web/20190821194208/https://www.nytimes.com/2017/02/15/magazine/the-compost-king-of-new-york.html>.
153. Practice Greenhealth, *State Mandates on the Purchase of Recycled Content Paper*, 2010, archived at http://web.archive.org/web/20171019142300/https://practicegreenhealth.org/sites/default/files/upload-files/state_mandates_on_the_purchase_of_recycled_content_paper.pdf.
154. DeAnne Toto, “Update: California governor signs recycled-content bill,” *Recycling Today*, 25 September 2020, available at <https://www.recyclingtoday.com/article/recycled-content-legislation-california/>.

155. Sam Kean, "The sort of sad death of the mercury thermometer," *Slate*, 1 March 2011, archived at <http://web.archive.org/web/20210119022406/https://slate.com/technology/2011/03/the-sort-of-sad-death-of-the-mercury-thermometer.html>.
156. Asbestos bans: EWG Action Fund, Asbestos Nation, "Asbestos bans around the world," archived at <http://web.archive.org/web/20210312084800/http://www.asbestosnation.org/facts/asbestos-bans-around-the-world/>; health effects: Agency for Toxic Substances and Disease Registry, *Asbestos and Your Health*, 3 November 2016, archived at http://web.archive.org/web/20171228212258/https://www.atsdr.cdc.gov/asbestos/health_effects_asbestos.html.
157. European Commission, *REACH*, 8 September 2021, archived at http://web.archive.org/web/20180126224409/http://ec.europa.eu/environment/chemicals/reach/reach_en.htm.
158. *Ibid.*
159. 42 US Code ch. 137 § 14301.
160. American Society of Civil Engineers, *Hazardous Waste, 2021 Infrastructure Report Card*, 2021, available at <https://infrastructurereportcard.org/cat-item/hazardous-waste/>.
161. Heather Rogers, *Gone Tomorrow: The Hidden Cost of Garbage*, (New York: The New Press, 2005).
162. See note 77.
163. Tom Szaky, *Outsmart Waste: The Modern Idea of Garbage and How to Think Our Way Out of It*, (San Francisco: Berrett-Koehler Publishers, 2014).
164. Bankrupt: Romy Varghese et.al, "Harrisburg files for bankruptcy on overdue incinerator debt," *Bloomberg*, 12 October 2011, available at <https://www.bloomberg.com/news/articles/2011-10-12/pennsylvania-capital-harrisburg-files-for-bankruptcy-over-incinerator-debt>; Detroit: Alexander H. Tullo, "Should plastics be a source of energy?," *Chemical and Engineering News*, 96(38), 24 September 2018, available at <https://cen.acs.org/environment/sustainability/Should-plastics-source-energy/96/i38>.
165. Maja Robinson, Tishman Environment and Design Center, *The Cost of Burning Trash*, November 2020, available at <https://static1.squarespace.com/static/5d14dab43967cc000179f3d2/t/5fc55ac3e18c5c478eadbcce/1606769348005/Massachusetts.pdf>.
166. Libby Solomon, "Wheelabrator sues Baltimore County for not sending enough trash to its incinerator," *Baltimore Sun*, 12 April 2019, archived at <http://web.archive.org/web/20210317034422/https://www.baltimoresun.com/maryland/baltimore-county/ph-tt-wheelabrator-0417-story.html>.
167. E.A. Crunden, "Baltimore grants Wheelabrator 10-year contract extension, with emissions requirements, to settle suit," *Waste Dive*, 5 November 2020, available at <https://www.wastedive.com/news/baltimore-wheelabrator-lives-on-controversy-zero-waste/588279/>.
168. Nate Seltenrich, "Incineration versus recycling: In Europe, a debate over trash," *YaleEnvironment360*, 28 August 2013.
169. See note 82.
170. Unproven at scale: Andrew Rollinson and Jumoke Oladejo, GAIA, *Chemical Recycling: Status, Sustainability, and Environmental Impacts*, June 2020, p.12, available at https://www.breakfreefromplastic.org/wp-content/uploads/2020/06/CR-Technical-Assessment_June-2020.pdf; no viable U.S. facilities: Denise Patel et al., GAIA, *All Talk and No Recycling: An Investigation of the U.S. "Chemical Recycling" Industry*, July 2020, p.3, available at https://www.no-burn.org/wp-content/uploads/All-Talk-and-No-Recycling_July-28.pdf.