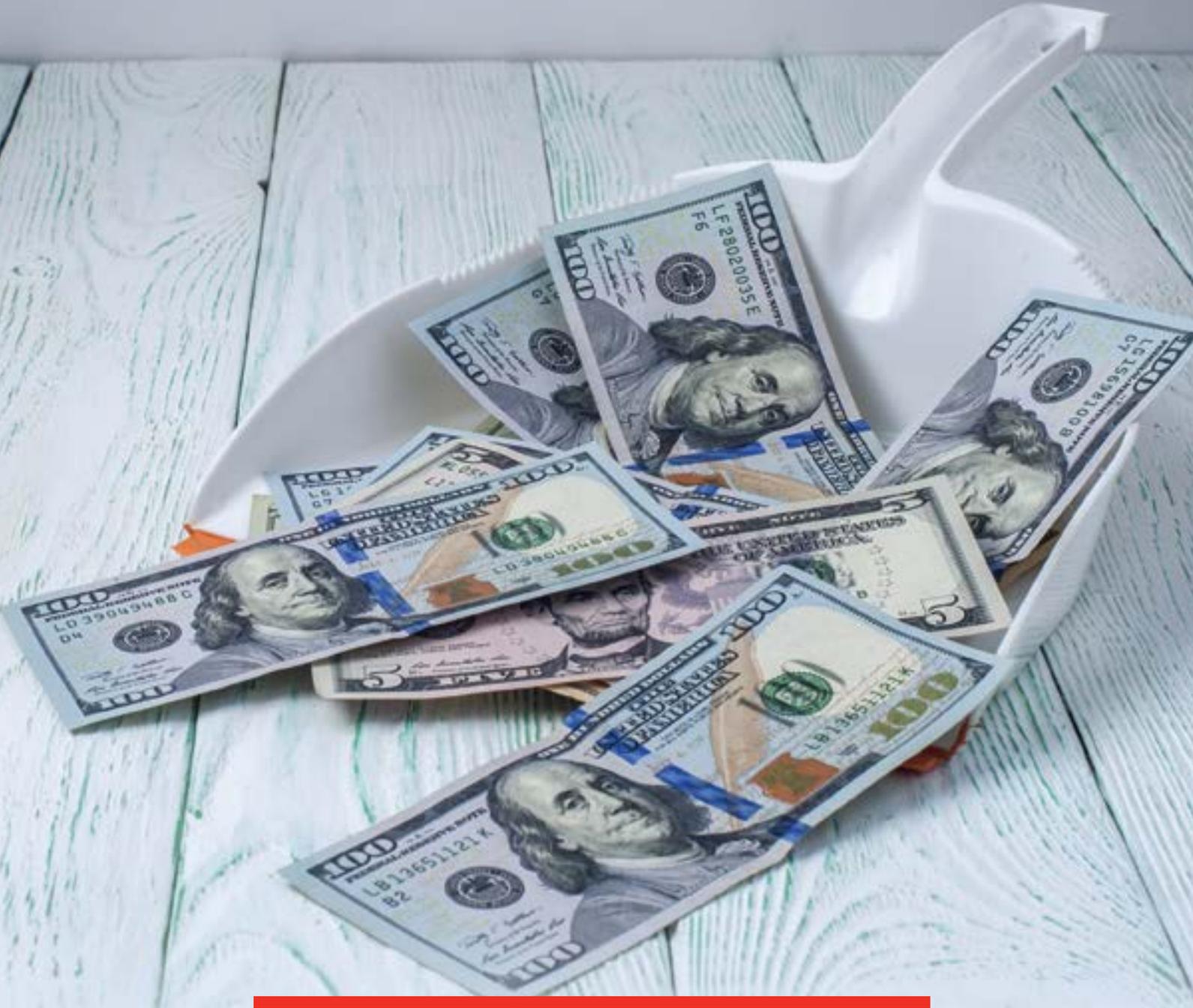




U.S. CHAMBER OF COMMERCE FOUNDATION
Corporate Citizenship Center

TRASH TO TREASURE



CHANGING WASTE STREAMS TO PROFIT STREAMS

TRASH TO TREASURE: CHANGING WASTE STREAMS TO PROFIT STREAMS

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U.S. CHAMBER OF COMMERCE FOUNDATION
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THIS PROJECT WAS MADE POSSIBLE THROUGH THE SUPPORT OF:



EXECUTIVE SUMMARY

Waste production is a serious problem for all American companies and industries. The largest 5,589 publically traded businesses in the United States sent 342 million metric tons of waste to landfills and incinerators in 2014. That is the equivalent of sending the weight of three Empire State Buildings to a landfill every day.

Removing unwanted resources to landfills or incinerators is a costly proposition in the price of removal, in the value of the resources being destroyed, and in the social impacts of greater waste amounts. By not accurately estimating, measuring, and managing their waste streams, American companies are throwing away significant opportunities for profit and increased efficiency, and improved brand.

Waste manifests itself before, during, and after the production process because production can be inefficient and wasted resources are not captured effectively. Waste affects all industries regardless of size and whether they are manufacturing products or offering services.

There are significant opportunities for companies to properly value their waste streams and make changes to their processes to take greater advantage of cost savings and new profit streams. For some companies, those opportunities exist in their own value and production chains. They can improve the efficiency of processes, package goods more effectively, and find ways to sell or donate their waste as raw materials for other companies.

For others, those opportunities exist outside of their companies. Some can work with consumers of their goods to get used products back for refurbishing, while others can develop industrial services to treat waste

or turn it into energy. In all these cases, improving the ability of companies to measure and eliminate their waste are important steps to capturing lost opportunities.

By understanding the size and value of the waste stream, and how to monetize it, companies can reduce waste going to landfills and incinerators. In addition, long-term solutions include incorporating more sustainable closed-loop manufacturing processes to limit waste or rethinking the system entirely, shifting to a circular economy in which waste is designed out entirely.

Reconfiguring manufacturing and production to reduce waste and embrace more circular economy models can be a challenging prospect for any company regardless of size. That's why the US Chamber of Commerce Foundation's Corporate Citizenship Center (CCC), and our partners prepared this report to educate businesses across all industries about those opportunities.

To illustrate some of the ways that circular economy thinking can help eliminate waste and turn trash into treasure, this report also looks at how companies like Walmart, DSM, IBM, General Motors, Bridgestone, Dow, Veolia, Caterpillar, and Republic Services have been able to do just that.

This report was prepared with Trucost, experts in environmental data and natural capital valuation, who contributed data and analysis on the amounts, types, and flows of the waste produced by companies. The Ellen MacArthur Foundation contributed insights with broader strategies about how to capture that value and thematic support. Many have suggested "waste is a resource in the wrong place." This paper quantifies that statement and offers actionable ways to put waste in the right place.

OVERVIEW OF INEFFICIENCY AND WASTE

KEY INSIGHTS:

- Waste, throughout both production and consumption, is the consequence of inefficiency.
- The costs of waste come from the economic cost of removal and the environmental and social impacts.
- There is potential to turn waste into profit by avoiding those costs and properly valuing the waste stream.

One of the biggest drains on profitability on any company is the materials, resources, and time wasted because of inefficiencies. The clearest physical manifestation of inefficiency is the amount of materials that companies send to either landfills or incinerators.¹ All those resources entered the company's production chain with value, but leave it with none.

In addition to the cost of sending waste to treatment facilities, which can vary greatly based on region, type of waste, and the

processing company; waste generation incurs costs on environment and society.² The quantification of those costs is complex because of the many factors associated with them.

Environmental impact costs to society arise from several different factors including increased emissions, leachate, and disamenity (i.e., noise, odor, and aesthetic) effects. Trucost calculated a range of possible environmental costs to society from waste disposed in landfills or incinerated, seen in Table 1.



Whether waste is sent to a landfill or incinerated, there are air emissions associated with its transportation and disposal. These emissions include greenhouse gases, air pollutants, dioxins, and heavy metals, all of which can impact air quality and health. When waste is sent to landfills, landfill gas (50% methane, 50% carbon dioxide and trace non-methane organic compounds) is created as a by-product of the decomposition of organic material.³

The air pollution caused by these landfill gasses and the emissions of incinerators can lead to lower agricultural yields, forest die-back, and damage buildings through acid rain and other particulates.⁴

Leachate at landfill sites also imposes environmental costs. Leachate is generated when soluble components of the waste stream are transported out of mixed waste through the action of water passing through waste sites. Leachate may contain high concentrations of organic and inorganic contaminants and can enter the soil and migrate to surface water and groundwater. This could potentially result in adverse environmental and/or health problems, particularly if leachate enters the food chain.⁵ In addition, treating leachate can be difficult and costly for municipalities either on or off-site.⁶

Many of the environmental impact costs to society generated from waste arise through waste treatment plants and can be reduced through waste minimization efforts put forth by organizations that produce waste. These costs can be avoided or reduced, and waste minimization can help conserve natural resources associated with raw material extraction and waste disposal as well as energy and water used for processing waste and raw materials.

This would also help manufacturers reduce regulatory burdens and risks associated with disposal. In addition, as consumer preferences shift towards products and manufacturers that can demonstrate environmental benefits, intangible benefits arising from increased brand reputation, or a "halo effect," can be realized by these producers.⁷ While the environmental costs to society and intangible costs to manufacturers arising from waste generation and disposal can be difficult to price and account for, they should not be overlooked considering the far-reaching effects of the impacts.

Before a company can address its waste management and institute strategies to reduce waste in its production or services, it must first measure what it wastes, particularly in amount and type. Generally, that waste either occurs in the production

Table 1 – Waste's Environmental Cost to Society

Disposal Route	Environmental cost to society (per metric ton of waste)	Cost for 5,589 Companies under consideration
Landfill	\$88 to \$173	\$30 to \$60 billion
Incineration	\$64 to \$171	\$22 to \$58 billion
Weighted Average	\$90 to \$170	\$31 to \$58 billion

process, “pre-consumer,” or after its sale, “post-consumer.”

Post-consumer waste can be difficult for companies to measure or manage since it involves influencing consumer behavior after the point of sale. Encouraging recycling and returns are helpful, but this is not as effective as many companies would want them to be since they depend on the actions and attitudes of the consumer.

Pre-consumer waste is easier for companies to measure and control, since it either happens in their own facilities or in the facilities of their value chain. Opportunities for turning that waste into profit are also clearer, since it is simpler to determine the cost of inputs and the cost of waste removal.

Once a company determines the amount and location of waste production in its processes, the next step is to find a way to reduce that waste. The most direct way to do that is to prevent it from ever occurring by changing production processes. Making sure that raw and refurbished material, including commodities, space, water, and labor, are used efficiently is the first step in

reducing waste and recovering losses from those inefficiencies.

For a firm to measure wasted resources, it takes a concerted effort to track inputs versus outputs of all types of resources. It also requires auditing how much waste is produced, what types of waste are produced, how that waste is removed from facilities, and the cost of that removal. Republic Services, one of the leading national recycling and waste companies offers a service called BluePrint™ Waste Assessment to help companies with this task, which can be difficult for any one company to complete or contextualize.

CCC, along with Trucost and Ellen MacArthur Foundation, have come together to create this report that scans 5,589 large U.S. companies across 17 different industries to look at the constituent parts of each industry’s waste, broken into different commodity types, and see where there are the greatest opportunities in each industry to turn its trash into treasure.⁸ Later, the research offers examples of how some individual companies are working successfully to change their waste streams into profit centers both in the pre- and post-consumer fields.

THE VALUE AND OPPORTUNITY COST OF WASTE ACROSS ALL INDUSTRIES

KEY INSIGHTS:

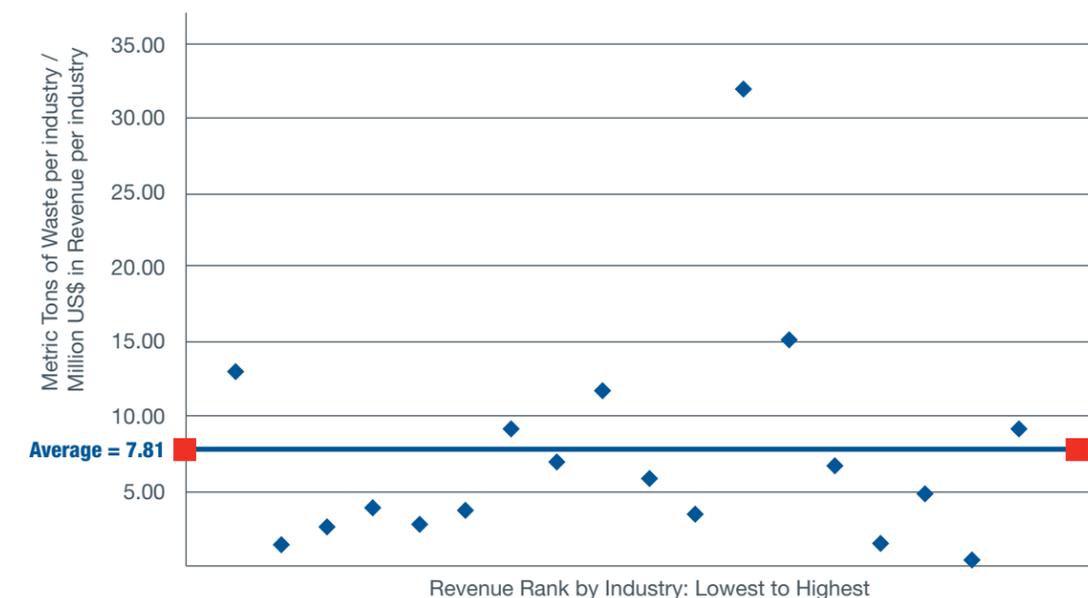
- The 5,589 largest public companies in the United States sent 342 million metric tons to landfills in 2014.
- There are opportunities to capture the lost value in that waste by companies of any size and in every industry.
- Paper (37%), Other Organic (21%), Plastic (17%), Construction (11%), and Metals (8%) make up most of that waste.

The waste that companies send to landfills represents inefficiency or lost opportunities for potential income. Through their value chains, 5,589 of the largest publicly traded American companies sent 342,493,476 metric tons to landfills in the United States in 2014, which is equal to the sending the weight of the U.S. adult population to landfills every three weeks.⁹

To show that there are opportunities to reduce waste and increase profitability for

all industries regardless of their operations or size, the research computed a Waste Intensity metric for each industry. Each industry’s total waste tonnage was divided by its total revenue in millions of US dollars for 2014, and plotted on Chart 1. On average, industries waste 7.81 metric tons of materials for every million dollars of revenue. There was no significant relation between the size of the industry’s revenue and its waste intensity. This means that there are opportunities for companies to reduce waste regardless of industry or size.

Chart 1: Waste Intensity by Revenue Rank



Trucost and CCC reviewed the total amount of waste sent to landfills by those companies throughout their value chains. To evaluate this waste by type, Trucost was able to break down that 342 million metric tons of waste into nine different categories: Paper, Glass, Metal, Plastic, Other Organic, Construction, Hazardous, Special, and Mixed. A specific description of these wastes is included in Appendix 1, and the breakdown of waste by type for all companies is seen in Chart 2.

Our research found that paper products make up the largest percentage of corporate waste (37%), followed by other organic (21%), plastic (17%), construction/demolition (11%), and metal (8%). Appendix 2 includes charts showing the waste by type data for each North America Industry Classification System (NAICS) industry. The following section discusses each of these five major waste streams for corporations, potential cost savings in reducing waste in each, and

insights on how remaining waste can be changed from waste to profit.

Paper

In 2014, the 5,589 companies in the study wasted 127 million metric tons of paper, which stacked neatly in one pile would be a cube with sides of about half a kilometer, which is close to 4 million stacks of 8.5 x 11 inch paper roughly 10 million sheets high.

Ninety percent of paper production comes from wood pulp, which itself is a mix of sawdust, logs, and recycled paper. The cost of wood pulp has been volatile over the past 35 years, making it difficult to create resiliency against those price changes, as illustrated in Chart 3. In the past 15 years, wood pulp prices oscillated between \$600 and \$850 per metric ton.¹⁰ Changing systems so that they use even 1% less paper can introduce nearly \$1 billion in savings across all industries.

The research found that Utilities, Information, and Finance/Insurance companies have greater opportunities to reduce paper waste. The requirement of many of these companies to produce paper notices and bills adds significant cost and paper usage. While most of these companies offer digital versions of these notices to reduce paper, regulations can sometimes require printed copies of bills, prospectuses, and summaries, resulting in tons of waste.

The biggest way for companies in those or in any industry to reduce paper waste is to limit the use of paper in general since there is not yet a developed secondary market for paper. When paper must be consumed, recycling paper is still an effective solution since creating paper from recycled paper is more energy efficient than creating paper from new wood pulp.

Organic

In 2014, the companies in this study waste roughly 72 million metric tons of

organic materials that was not included in the paper category. In some instances, that organic waste may consist largely of plant matter and textiles; but in a majority of company examples food makes up a high percentage of organic waste. The value of that waste can be difficult to quantify effectively, but the World Bank's Global Economic Monitor tracks a basket of food commodities that use 2010 as the index year. Looking at that basket of food commodities from the past 55 years, food prices can change quite dramatically, with a low of 60% of 2010's cost in 1999, and 180% of 2010's cost in 1973, and is illustrated in Chart 4.

There is another value of food waste and that is its role in food insecurity for people around the world. By decreasing the amount of food that is wasted, that allows for those once-wasted calories to be used more effectively, either as food for individuals in need, feed for livestock, or converted into energy as fuel.

Chart 2: Waste by Type - All Industries

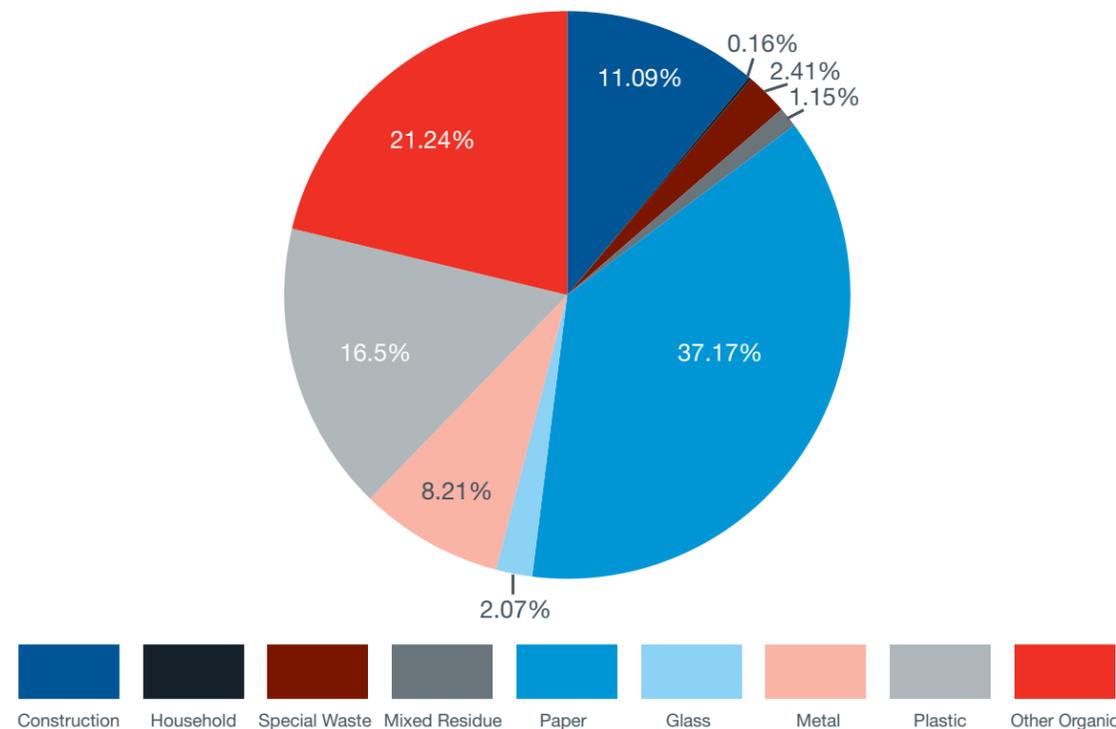
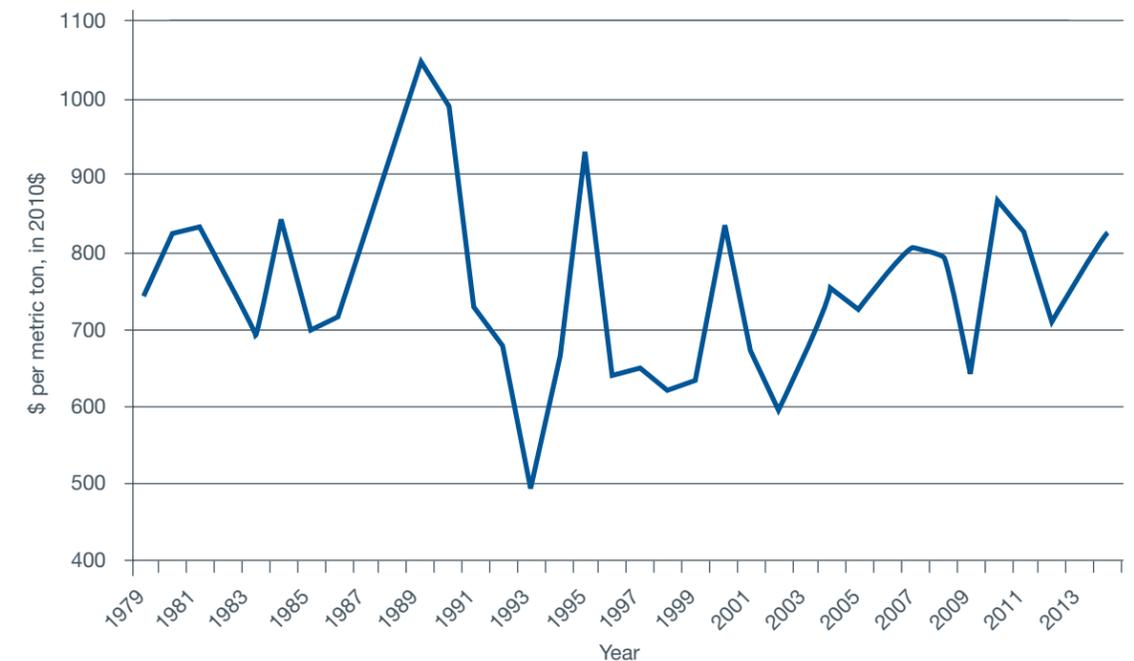


Chart 3: Wood pulp



Trucost's research found that companies in the Educational Services, Agricultural, and Arts and Entertainment industries have the greatest opportunities to gain profit from reducing food waste. This should be no surprise as these industries are the ones that produce food and are responsible for much of the distribution of it. While food retailers and producers have more flexibility to deal with food since it is not prepared, schools and entertainment facilities have fewer options to handle mass amounts of prepared food without wasting it. Weighing the safety of food with the potential of wasting it is a difficult balance, but it can be achieved by making smart decisions on how much food to prepare and distributing it in a way that limits waste.

Incorporating systems that keep uneaten food out of landfills is also a way to limit waste, and includes turning waste into energy and developing commercial level composting.

Plastics

The companies in this study wasted roughly 58 million metric tons of plastics in 2014. Plastics come from a wide variety of raw materials, including feedstocks, natural gas, and crude oil, so it can be difficult to

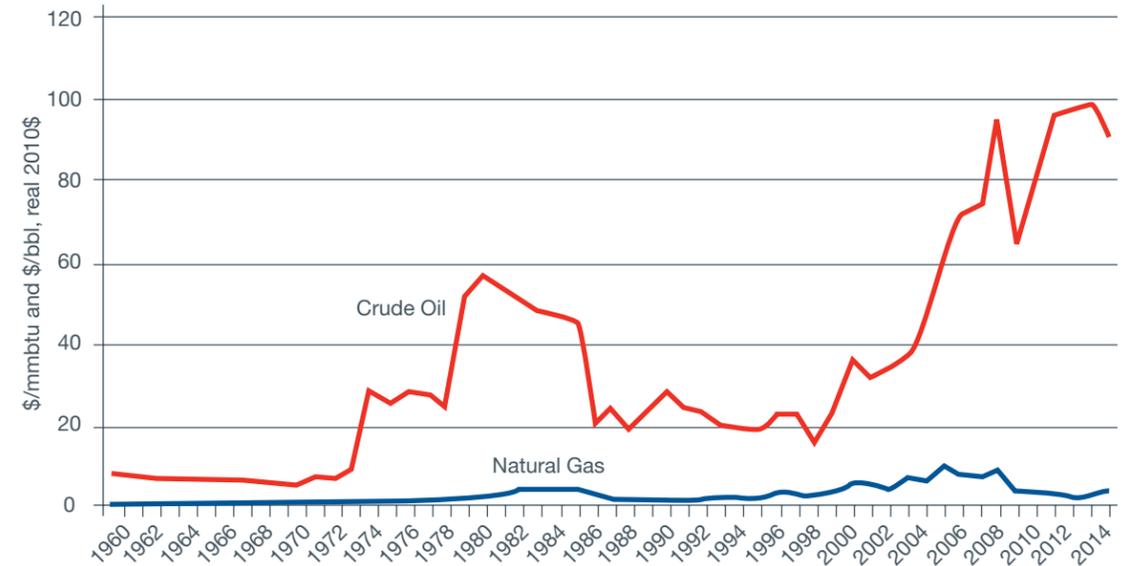
track the exact cost of the inputs required to create virgin plastic. However, the energy cost of producing plastics is usually much higher than producing other types of raw materials, including paper, lumber, and metals. By reducing the waste of plastics, companies can save both on the raw resource cost to produce plastic and the energy cost to manufacture it.

Charts 5 and 6 show the cost of the raw materials and energy of creating most types of plastic. For inputs, crude oil has shown especially significant changes, with the downward trend in 2014 continuing through 2015.

Reusing plastic can be more energy efficient than creating new plastic through virgin materials, though this is largely dependent on the price of crude oil and limited by technological barriers to what types and forms of plastic that recycled plastic can become.

Nevertheless, limiting plastic waste is profitable regardless of the cost of energy, crude oil, or natural gas. Of all the industries under consideration,

Chart 5: Cost of Creating Parts of Plastic



Manufacturing has the biggest opportunity to make gains from repurposing plastic waste. It has the highest rate of plastic waste of any of the industries because of

production processes that do not use raw plastic efficiently, plastic's role in shipping and storing goods, and end-of-life waste of plastic materials.

Chart 4: Price of Food Commodities

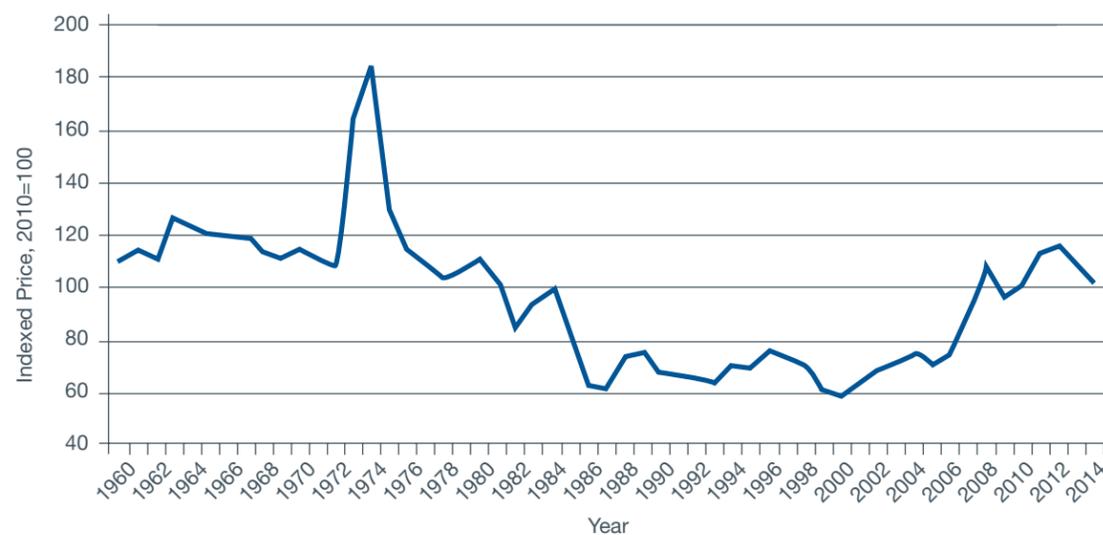
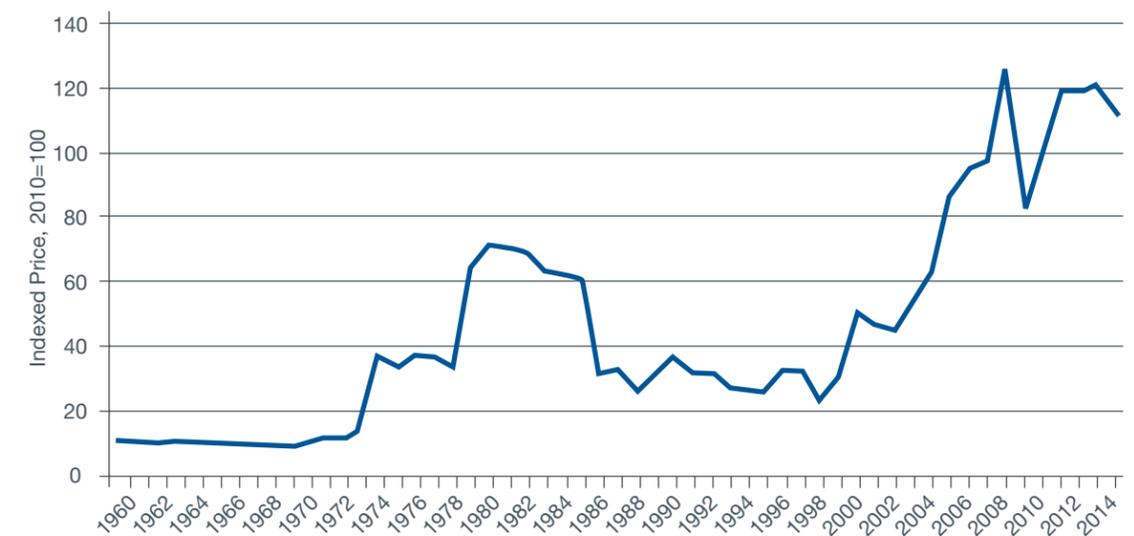


Chart 6: Energy Prices



Construction

Companies wasted about 38 million metric tons of construction and demolition materials, mostly concrete, asphalt, gypsum (one of the main components of drywall and other construction goods), and lumber. Over the past 30 years, the materials required to make concrete, which are largely similar to the materials needed to make asphalt, have been steadily increasing in cost. From 1982 to 2005, the cost of concrete increased 79%. It increased another 80% in the 10 years since then.¹¹ Along that same 33-year period, gypsum prices have been more volatile, but its cost has steadily increased 50% in the past 10 years.¹²

Even though lumber has been more stable than concrete and gypsum in the past 15

years, the costs of plywood and Malaysian logs and sawnwood changed drastically in the 1990s. Limiting the waste of construction goods by reusing them or instituting more resilient building practices can help ameliorate these price risks and create more opportunities for profit.

The agricultural, transportation, and construction industries have the most potential to gain profit from decreasing construction and demolition waste. Unlike some of the other commodities, there is a more robust market for construction “waste,” as reclaimed lumber, masonry, and metals all have secondary markets for individuals looking to build with these materials for aesthetic, economic, or environmental reasons.

Chart 7: Costs of Gypsum and Concrete

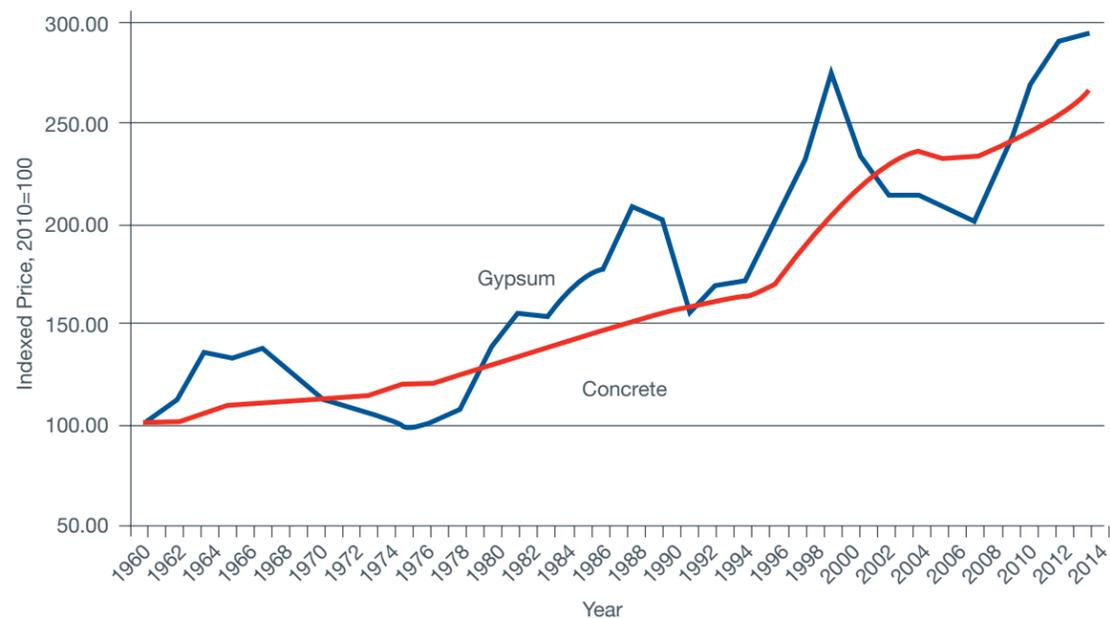
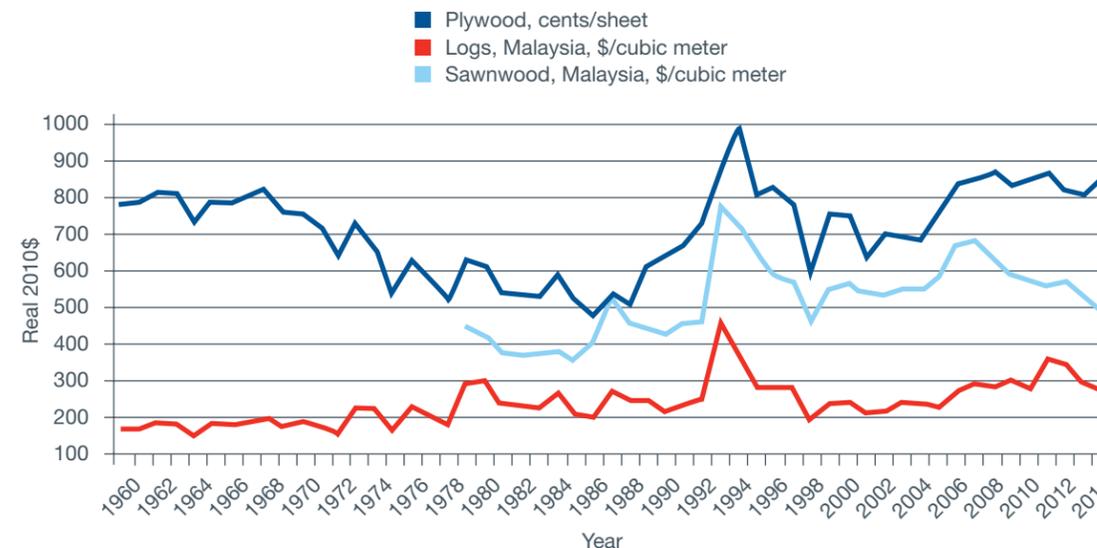


Chart 8: Costs of Wood Products



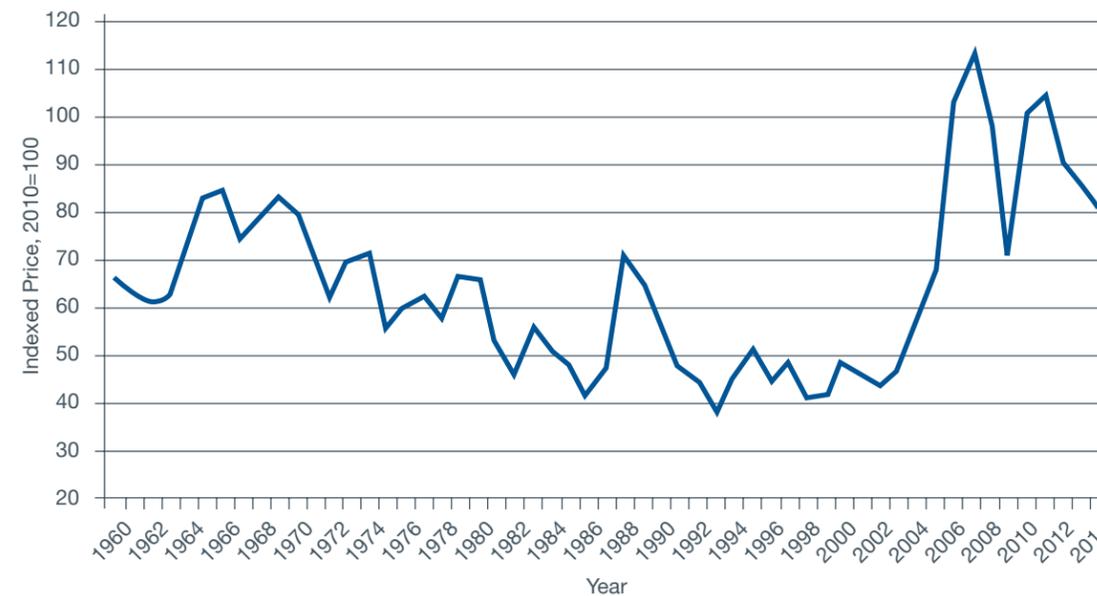
Metals

Companies wasted about 27 million metric tons of metals, ranging from the tin and aluminum used for canning food to the steel, lead, and other metals required in manufacturing and refining. American industry recycles a lot of metal, including about 68% of aluminum and 88% of the steel it produces, showing that there is already an infrastructure

in place to limit the waste of metals.¹³

The cost of metals and minerals from 2000 to 2007 increased nearly 300%. Since then, prices have fluctuated plus or minus 40%, making it even more important to limit the waste of metals and minerals to build resiliency to these significant price fluctuations, illustrated in Chart 9.

Chart 9: Commodity basket of Metals and Minerals



VALUING WASTE AND MONETIZING ALTERNATIVES

KEY INSIGHTS:

- Companies are already working to reduce waste and are increasing profits because of it.
- Internal programs concentrate on in-house production and consumer outreach.
- External programs use a company's core competency to reduce waste for other organizations.

The previous section shows that there is a lot of value in waste, both in avoiding its production and in changing that waste into a new resource and recovering its value. This section looks at examples of how companies have accomplished it. From measurement to execution of programming to ensuring that all their stakeholders are on board, these companies have shown that is possible to turn trash into treasure.

Walmart

Walmart has a broad-focused program that incorporates Sustainable Design and

Manufacturing, and it looks at the entire life cycle of the products it sources and sells.¹⁴

Walmart starts by working deep in its supply chain to examine what goes into its products, and it works with all types of suppliers to impact how its products are packaged and how much reclaimed and recycled material go into the product. The company also works with partners that help their suppliers become more efficient by eliminating waste and increasing energy efficiency.

These sustainable design and manufacturing strategies go toward Walmart's goal to

generate zero waste in its facilities by reducing, reusing and recycling the materials it uses. In its Zero-Waste-to-Landfill programming, Walmart tracks key data across 50 separate waste categories and uses that information to make more efficient decisions about reducing waste.¹⁵

These programs have enabled Walmart to launch an internal food waste and damage reduction campaign that in 2014 helped keep an estimated 30 million units of food from becoming waste. Some of this saved food was able to stay on the market because of more efficient production processes, but some of it was part of the 571 million pounds of food Walmart donated in 2014. Across all its operations in the United States, Walmart has been able to reach 82.4% waste diversion, keeping tons of waste out of landfills and turning it into resources to be used for other purposes.¹⁶

Walmart's focus on waste diversion and environmental sustainability led it to fund the Closed Loop Fund along with Coca-Cola, Colgate Palmolive, Goldman Sachs, Johnson & Johnson, Keurig Green Mountain Coffee, PepsiCo, Procter & Gamble, Unilever, and 3M. The Closed Loop Fund offers 0% loans to municipalities and low interest loans to private companies to develop a broad array of waste reducing and sustainable infrastructure and technologies. This intercompany partnership funds \$100 million worth of projects with the goals to eliminate greenhouse gas emissions, divert waste, and create jobs in the sustainable economy.

DSM

Food and organic waste is a major component of all corporate waste. One of the ways that companies have reduced that type of waste is to use it to create fuel. While some of these programs depend on growing crops specifically for fuel or the localized collection of used cooking oil, DSM has partnered with POET, LLC to create a new form of cellulosic bio-ethanol.

Instead of using new crops or post-consumer oils or waste, DSM's program works with industrial-level corn crop residue, cobs, leaves, stalks, and husks that are left after the corn has been harvested. Farmers generally produce about 1 ton of this type of residue per acre, and Project LIBERTY will consume about 285,000 tons of that residue annually, purchasing it from area farmers at about \$46 an acre who are incentivized to turn that waste stream of residue into a profit center.

Project LIBERTY will process 770 tons of corn cobs, leaves, husk, and stalk daily to produce 20 million gallons of cellulosic ethanol per year, later ramping up to 25 million gallons per year. Project LIBERTY will be the flagship plant in POET-DSM Advanced Biofuels' plan to license this technology to companies across the United States and around the world. By expanding this project globally, thousands of tons of waste will be turned into energy and profit.¹⁷

IBM

IBM looks at waste reduction and item reuse through its product stewardship programming, which has been in place since 1991. More than 20 years of practice have made IBM quite successful with these strategies.

In 2014, IBM's end-of-life management operations processed 32,000 metric tons of end-of-life products, products that were both pre- and post-consumer. Of those 32,000 metric tons, IBM recycled 54.9%, refurbished and resold 34.9%, reused 6.8%, sent 2.9% to waste-to-energy programs. IBM only sent 0.5% to landfills.¹⁸ That is a marked improvement over IBM's already low rate in 2005, when it sent 2.2% of its product end-of-life management operations to landfill or incinerator.¹⁹

Aside from having a strong overarching program to drive product stewardship, IBM is able to accomplish these gains by keeping specific data and measurement. The ability



to benchmark and track across different waste streams is paramount to knowing how to eliminate waste inefficiencies.

Product stewardship is not the only way IBM has changed its waste. In 2014, IBM's global packaging engineering team saved an estimated 101.6 metric tons of packaging materials through product and packaging redesign. Not only was that material kept out of landfills, it saved IBM \$2 million in annual material and transportation cost savings.²⁰

That \$2 million is only a fraction of the savings that IBM has experienced through its environmental programs, product stewardship, and other waste reduction strategies. Between 1998 and 2007, IBM saved more than \$100 million through its environmental programs.²¹

General Motors

In 2011, General Motors (GM) set a goal to achieve 100 landfill-free manufacturing and 50 landfill-free nonmanufacturing sites by 2020, and in October 2014 reached 89 and 33 globally. GM started its waste reduction plans as a financial goal, and tied revenue to waste streams and managing waste streams.²²

When GM started its landfill-free program in 2011, it invested about \$10 for every 1 ton of waste. But by 2014, the company was spending less than \$1 for every ton, making the economic gains from waste removal and the more efficient use of resources even more profitable over time. By 2014, GM approximated its annual revenue from by-product, recycling, and reuse at \$1 billion a year. Keeping materials out of landfills

and incinerators, allowed it to recover a significant revenue stream.²³

GM instituted new production systems that involve more closed-loop processes, using materials previously seen as waste in production. Within GM's manufacturing system, cardboard packaging gets turned into headliners and used plastic gets turned into air deflectors. Resources formerly considered waste also gets brought in or sent out. Wood pallets are formed into beams and sold to the construction industry, or donated to communities for use in community gardens and other projects. Food scraps from its cafeterias gets composted and turned into fertilizer. This focus also extends to the consumer use of products, as GM vehicles are designed to be 85% recyclable at the end of their useful automotive life.

Bridgestone

For companies that offer few products to market, it can be particularly worthwhile to develop systems that reuse waste in a way that builds value both financially and socially. Bridgestone, with its focus on tires, has established its Tires 4ward program to collect more than 10 million spent tires since 2012. All the tires they collect go on to another useful purpose, such as floor mats, paving, asphalt, mulch, and as a component in new tires that Bridgestone produces in its "Ecopia" line of tires.

Bridgestone accepts any brand of tire, which means it can maximize the benefit from recycling tires from all their competitors, and helps build brand loyalty by bringing all tire customers into its shops.

CIRCULAR ECONOMY: RETHINKING THE SYSTEM

KEY INSIGHTS:

- **The circular economy model is a different way to think about production and consumption that changes the linear "take, make, dispose" model to one that is restorative and regenerative by design.**
- **Designing and implementing circular economy processes into production and design of products and services offers significant long-term advantages.**
- **Circular economy models can help reduce the need for virgin materials, help find new markets for by-products, and offer better connections to consumers.**

This report thus far has focused on quantifying the value of utilizing waste as a resource and has highlighted the ways that companies are reducing waste or turning it into profit. However, waste is a symptom of a system that does not work. A more systemic approach to framing the issue involves profoundly reshaping the economic system into one where waste is designed out by intention – a circular economy.

The majority of current production processes follow a linear "take, make, dispose" model. In this model very little attention is paid to how products, their components, or the resources used to make them will be used over and over again. The result is that most resources are largely used for a single purpose only and then discarded as waste.

A circular economy, in contrast, is restorative and regenerative by design, keeping products, components and materials at their highest utility and value at all times. The aim is to keep both raw and finished materials within the system for as long as possible, decoupling economic development from the consumption of finite resources. A circular economy incorporates pre- and post-production systems that keep products in service for a long time, and plans for their effective repurposing time and again. This often takes the shape of leasing and service arrangements for home appliances, or the complete repurposing of returned goods such as industrial machinery or commercial furnishings.

Quite often, designing a circular system involves a reconfiguration of a company's



business practices. Design and production processes have to be adjusted to construct goods with extended product life, either through increasing durability or by allowing for the replacement of components through repair, refurbishment or remanufacture.

Even more revolutionary for some companies is the change in their relationships with their customers or users through innovative business models. To be refurbished or recaptured, many of these products need to return to the supply chain. While this is more common in the industrial setting, or with automobiles in the consumer setting, the lack of adequate collection schemes and infrastructure makes it difficult for users to return products to a retailer or producer.

The companies highlighted in the previous section are great examples of how to incorporate aspects of the circular economy. These companies are using broader circular economy programs to eliminate waste by design.

Dow

Dow Terneuzen, Dow Chemical Company's largest chemical, is in a major seaport and is a freshwater-scarce coastal area in the Netherlands. The area faces competing water demands from agriculture, industry, and housing, ultimately making water management difficult. To help manage freshwater use and reuse on site, Dow has collaborated with private-sector companies and the city of Terneuzen to implement a program in which its plant accepts wastewater each day from the city, has it purified by a third party, and reuses it for its industrial processes. As a result, the site reuses 30,000 cubic meters of municipal wastewater each day and has reduced its energy use associated with water treatment by 95%. This has reduced the plant's carbon dioxide emissions by 60,000 tons each year, a saving equivalent to planting more than 1.5 million tree seedlings over the course of a decade.²⁴

Veolia

Veolia, a water utility management company, also works to support the circular economy of water by making wastewater reusable for other functions. One specific example involves the treating of the hazardous water produced by refining gasoline. The refining process uses hydrofluoric acid that needs to be neutralized with potassium hydroxide (KOH), a process that creates hazardous water. Veolia is able to treat that spent KOH wastewater and return 95% of it to the refineries to be reused. This cycle creates economic and environmental benefits since it is less expensive for the gas refineries to pay to have spent KOH processed than create new KOH. Greenhouse gas emissions to refine the spent KOH are 40,000 tons less than creating new KOH, and it is 34% more energy efficient. The processing system also creates no new hazardous waste.²⁵

Caterpillar

Caterpillar is another top example of a company embracing circular economy processes. For the past 40 years, Caterpillar has employed a "design for remanufacturing" process where new parts and components can be remanufactured multiple times and used to repair, replace, or refurbish entire machines. All remanufactured products that Caterpillar processes are held to the same standards as their new counterparts, so reliability is not impacted, and the same warranty covers both new and remanufactured products.

This process also allows Caterpillar to stay in contact with its customers. Through its "Product Link," computers on the machine can report when parts need to be replaced long before they reach product failure. In addition, core deposits, which customers pay when purchasing new equipment, are returned to the customer when they bring the machinery back for repair or replacement. The rate of core returns in 2014 was 94%, showing that this offers great long-term relationship building with customers.²⁶ These companies, and others like them,

are ahead of the pack when it comes to incorporating circular economy fundamentals into their business practices. In these processes, waste is eliminated by reconfiguring systems to "design out" waste instead of making already-existing processes more efficient. As The Ellen MacArthur Foundation stated in *Towards The Circular Economy: Economic and Business Rationale for an Accelerated Transition*,

Whilst major strides have been made in improving resource efficiency and exploring new forms of energy, less thought has been given to systematically designing out material leakage and disposal. Any system based on consumption rather than on the restorative use of non-renewable resources entails significant losses of value and negative effects all along the material chain.²⁷

While those losses of value are significant for companies, there can be significant costs in changing their production systems to ones that favor renewable over non-renewable resources and optimize the yields of all resources. However, The Ellen MacArthur Foundation lists a number of circular economy processes that companies can use to remove or reduce waste and increase profitability.²⁸

1) **Preserve resource value** - Maintaining product integrity through strategies such as reuse or remanufacture lead to reduced costs as the embedded energy, materials and labor of a product are preserved. As a last resort, companies can recover value by incorporating recycling and composting programs to handle the waste that is not addressed with any of the previous methods, though it is not very effective at capturing the true value of the materials in many cases, metals excluded, and does not truly

address the overall processes that are producing waste.

- 2) **Improve customer relationships** - For companies selling directly to customers, redesigning products to be reused and refurbished increases the number of interactions with those customers when they return products and manage leasing agreements. Incorporating simpler product design, which allows for greater interchangeability of parts, can improve the design of finished products and thereby encourage customers to stay in contact with the company and develop long-term product and brand loyalty.
- 3) **Create new, effective, material flows** - Find new productive uses for byproducts. Two of the biggest terms in this space are industrial symbiosis and by-product synergy, both of which describe systems where companies work together to provide waste products from one process to use as a raw material in another. This collaboration can happen between individual companies, as when steel slag is sold to cement manufacturers as a useful component of cement. It can also happen through a municipality that works to bring a network of companies together to trade production by-products as input materials.

These circular economy methods are critical ways for companies to secure value from their waste streams. Instead of using gains in efficiency to find that value, companies that reconsider their entire production process can design-out waste and capture those profits by reducing raw material costs, selling more profitable service contracts, or ensuring that the by-products of their processes have ready and available markets.

Any system based on consumption rather than on the restorative use of non-renewable resources entails significant losses of value and negative effects all along the material chain.²⁷

CONCLUSION

The holistic system that companies use to rethink how they produce and treat waste, the circular economy, is growing in prominence around the world and corrects much of the waste and inefficiencies problems of production by creating systems that create less waste in the production and consumption of materials.

The Ellen MacArthur Foundation shows that by moving towards the circular economy, instead of remaining on a linear one, the economy of Europe can grow by nearly €1.8 trillion in the next 14 years. These types of gains are also possible in the United States. Finding and utilizing the value in those 342

million metric tons of waste discussed in this report is a major start to securing this economic opportunity.

“Waste is a resource in the wrong place” is a refrain that is gaining traction. Instead of thinking about waste as an inevitable byproduct, and cost, of doing business, it is time to think about waste as a valuable resource. By reducing the creation of waste and keeping it in its originally anticipated place as an input, rethinking waste as a resource to sell or extract value from, or adopting more circular processes, American companies have significant opportunities to put waste in its right place.



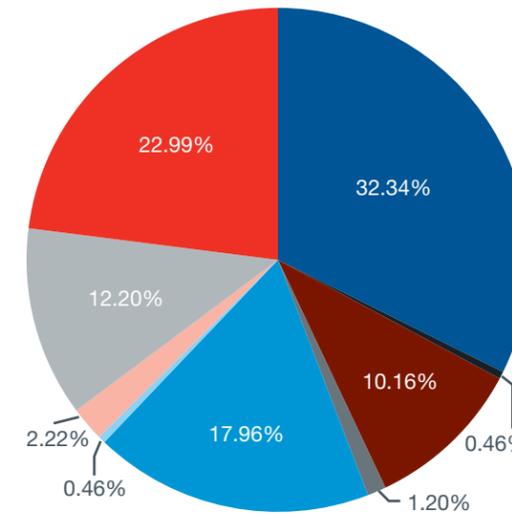
APPENDIX 1 – WASTE STREAM DESCRIPTIONS

Paper	Uncoated Corrugated Cardboard
	Paper Bags
	Newspaper
	White Ledger
	Color Ledger
	Computer Paper
	Other Office Paper
	Magazines and Catalogs
	Phone Books and Directory
	Other Miscellaneous Paper
Remainder/Composite Paper	
Glass	Clear Glass Bottles and Containers
	Green Glass Bottles and Containers
	Brown Glass Bottles and Containers
	Other Colored Glass Bottles and Containers
	Flat Glass
	Remainder/Composite Glass
Metal	Tin/Steel Cans
	Major Appliances
	Other Ferrous
	Aluminum Cans
	Other Non-Ferrous
	Remainder/Composite Metal
Plastic	HDPE Containers
	PETE Containers
	Miscellaneous Plastic Containers
	Film Plastic
	Durable Plastic Items
	Remainder/Composite Plastic

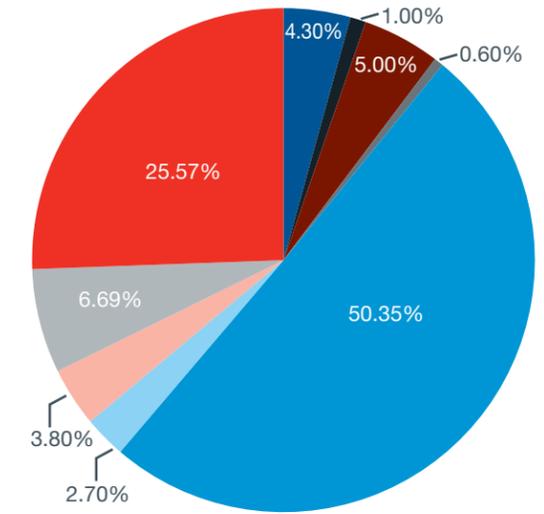
Organic	Food
	Leaves and Grass
	Prunings and Trimmings
	Branches and Stumps
	Agricultural Crop Residues
	Manures
	Textiles
	Remainder/Composite Organic
Construction and Demolition	Concrete
	Asphalt Paving
	Asphalt Roofing
	Lumber
	Gypsum Board
	Rock, Soil and Fines
	Remainder/Composite Construction and Demolition
	Household Hazardous Waste
Vehicle and Equipment Fluids	
Used Oil	
Batteries	
Remainder/Composite Household Hazardous	
Special Waste	Ash
	Sewage Solids
	Industrial Sludge
	Treated Medical Waste
	Bulky Items
	Tires
	Remainder/Composite Special Waste
Mixed Residue	Mixed Residue

APPENDIX 2 – WASTE STREAM PERCENTAGES BY NAICS INDUSTRY

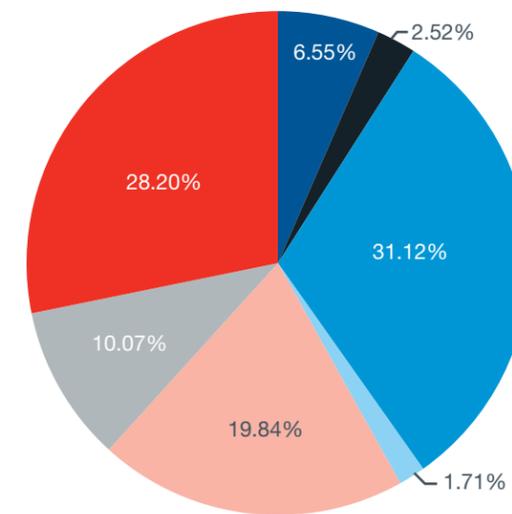
Agriculture, Forestry, Fishing and Hunting



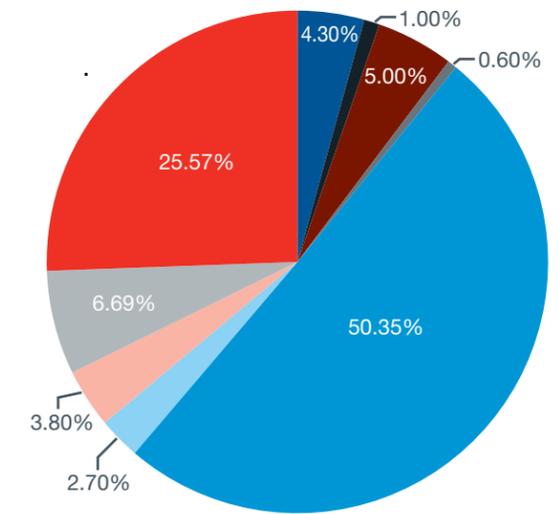
Real Estate, Rental and Leasing



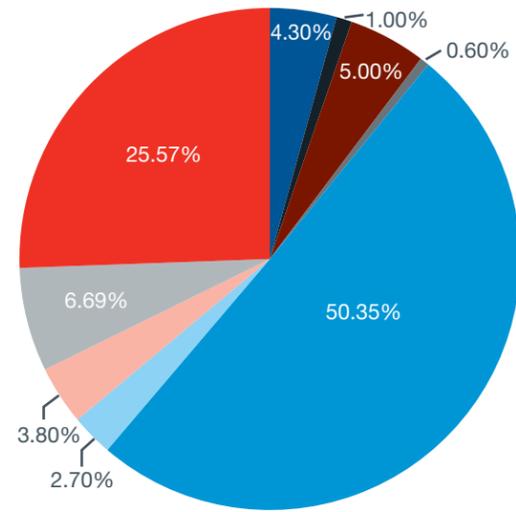
Mining, Quarrying, and Oil/Gas Extraction



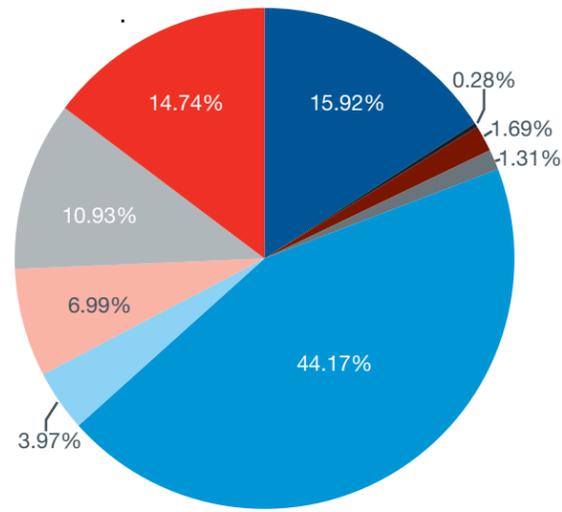
Management of Companies & Enterprises



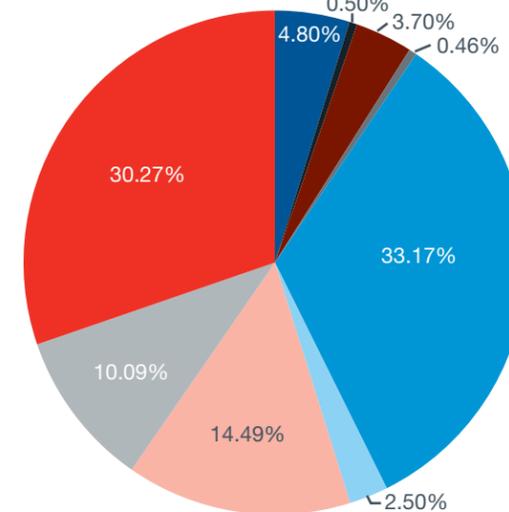
Professional, Scientific, and Technical Services



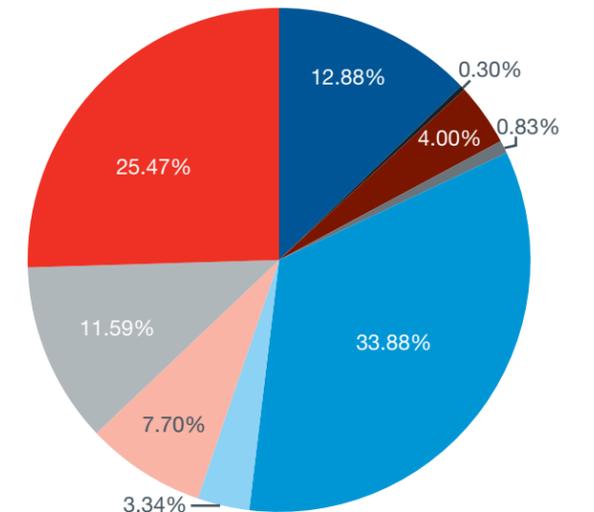
Transportation and Warehousing



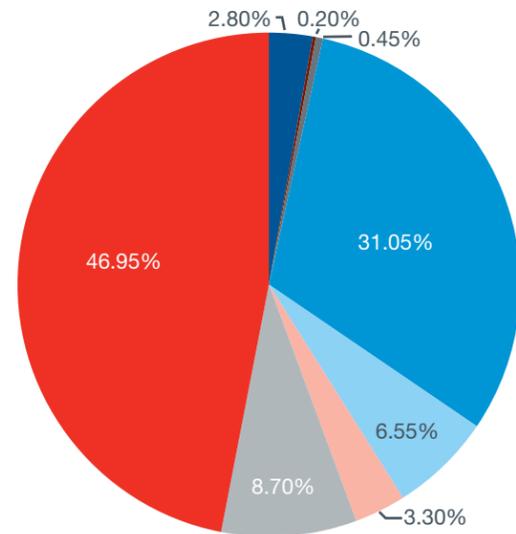
Arts, Entertainment, and Recreation



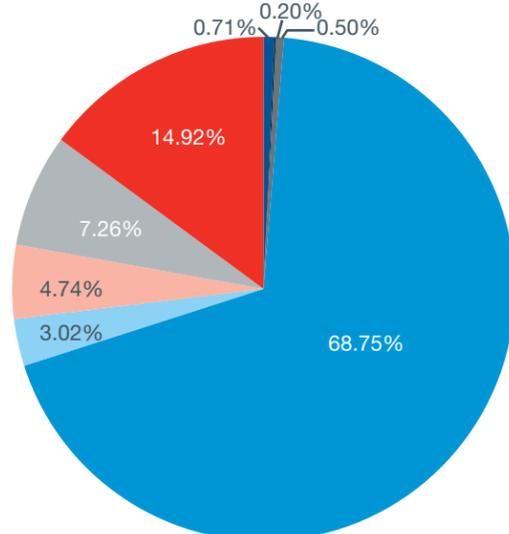
Retail Trade



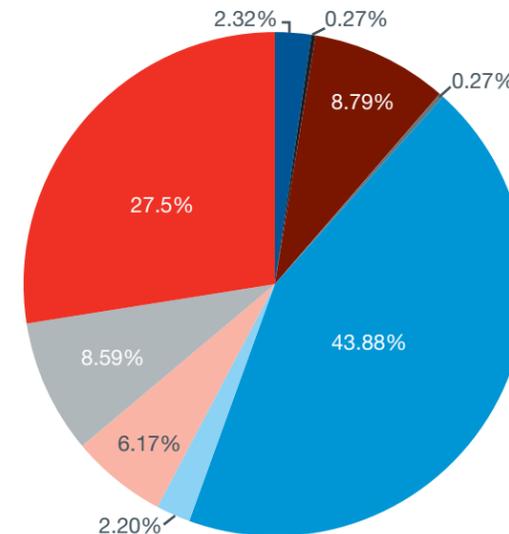
Accommodation and Food Services



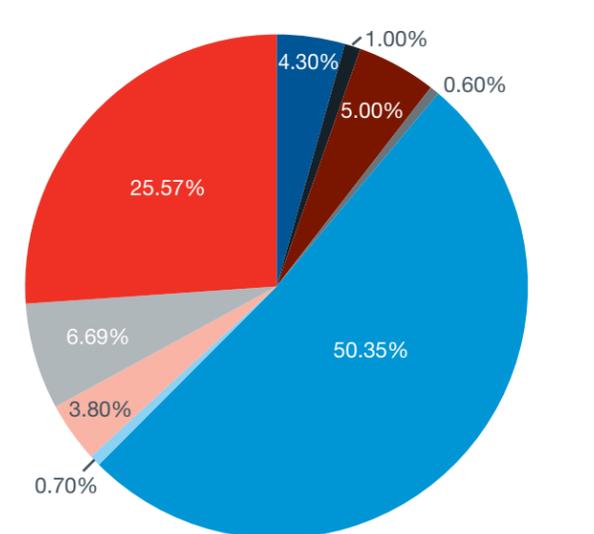
Utilities

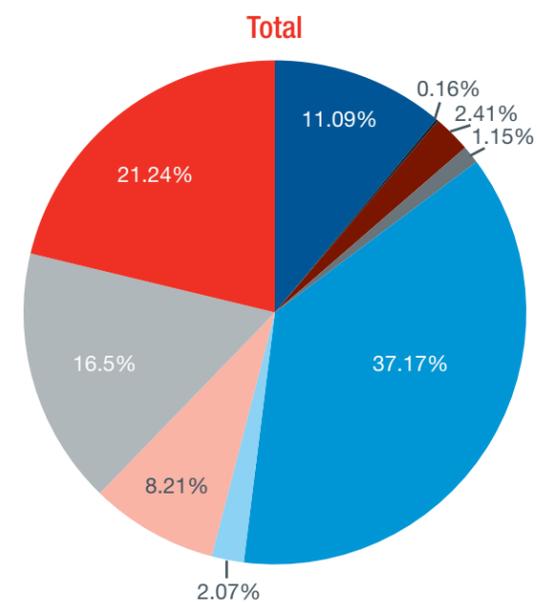
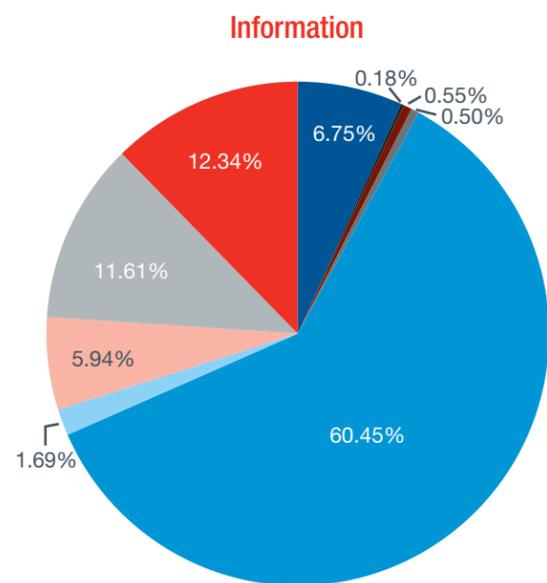
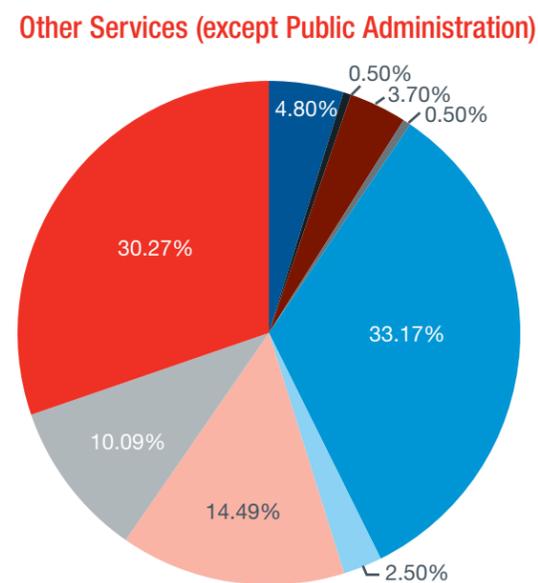
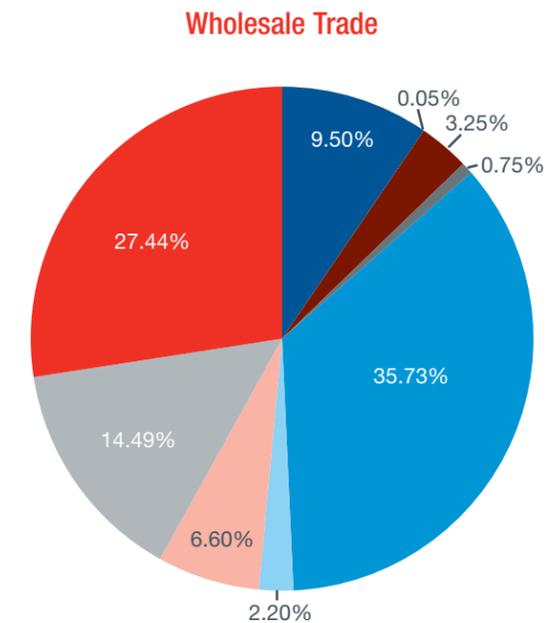
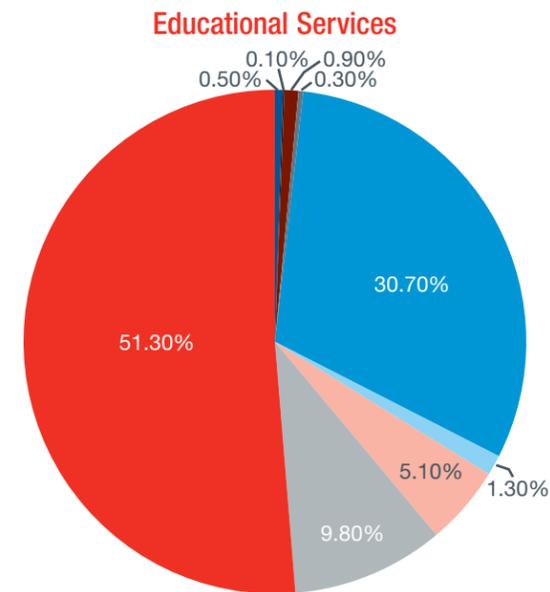
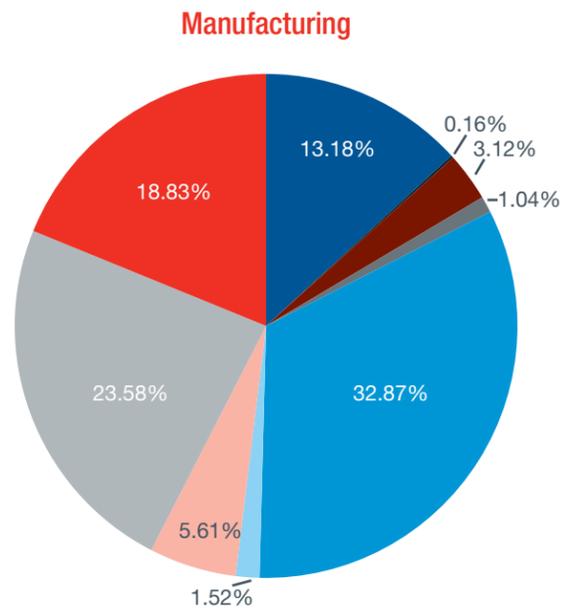
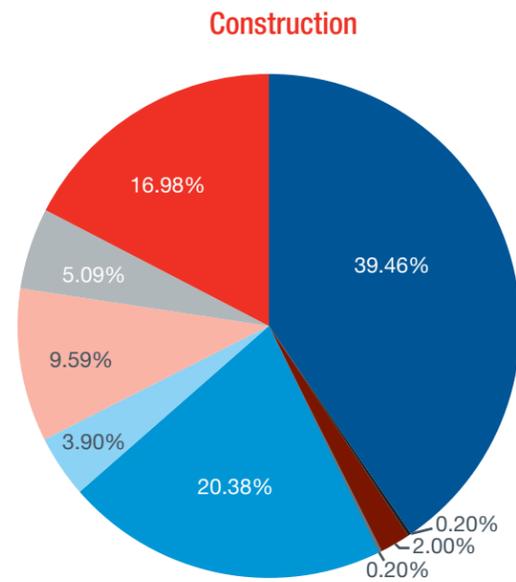


Health Care and Social Assistance



Finance and Insurance





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8. In this report, the 5,589 companies are sorted into industries by using their primary NAICS codes.
9. The EPA, in its “Guide for Industrial Waste Management” claims that American Industry produces 7.6 billion tons of solid waste, or about 20x the number stated here. This research concentrates on the 342 million metric tons reflects only large-cap publically traded companies, and the waste they send to landfills or incinerators throughout their supply chains. The 7.6 billion amount comes from all companies and includes all types of solid waste.
10. Unless otherwise specified, all commodity prices in this section come from the Global Economic Monitor (GEM) historical indeces released by the World Bank, available at data.worldbank.org/data-catalog/commodity-price-data
11. Data for the costs of concrete comes from the Bureau of Labor Statistics Producer Price Index, so only reflect U.S. costs (http://data.bls.gov/timeseries/WPU132?data_tool=XGtable).
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Lawrence Bowdish started consulting the Corporate Citizenship Center (CCC) on its Issue Network research in May 2013. He works closely with the research and issue network managers to create briefings, reports, and other research products, including *Aligning Communities*, on community health initiatives, *From Millions to Billions*, on women's entrepreneurship in Mexico, and *The Energy-Water Nexus Toolkit*.

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Previous to his work at CCC, Lawrence was a Professor of History at the American Military University, where he taught courses in American, Scientific, and Women's History. He was also managing editor for the history journal *Origins*, where he worked with authors who used history to illustrate current events.

Lawrence was also a consultant for county health departments that were instituting public health initiatives in Florida. There he developed curriculum, wrote grant proposals, and organized health program trainings.

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