July 2016

Investing in a Resource-Constrained World

Material Efficiency Analysis can Improve Returns & Reduce Risk

TERRA ALPHA
INVESTMENTS

Terra Alpha Investments, LLC is an advocacy investment firm established in 2014.

Our vision is to drive systemic change in our economy, so that it is more aligned with our natural systems.

Our firm's mission is to demonstrate that Environmental Productivity enhances long-term returns as expressed in real investment results and to advocate for the widespread adoption of Environmental Productivity across the global economic system.

At Terra Alpha Investments, LLC, we advocate for the accounting for and disclosure of relevant environmental data from company operations because we see it as material to thorough investment research and understanding corporate efficiency. Using company-reported data (not third-party estimates), we compare the resource intensities of companies to peers in their sub-sector. If a company surpasses a threshold of efficiency relative to its peers, it is eligible for investment consideration based on our fundamental and valuation analysis process.

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Introduction

Material efficiency has become a frontier of corporate innovation. Global development is putting unprecedented stresses on raw material supplies, and projected consumption trends exceed the carrying capacity of the planet. In short, many companies are faced with the imperative to make more money while using fewer materials. In an increasingly resource-constrained world, **companies that strategically optimize resource efficiency and recover maximum value from waste streams will be best positioned to thrive**.

The **traditional linear model** of a company's supply chain - take, make, and dispose - has undergirded global economic growth to this point. There is increasing corporate recognition that **this model is unsustainable for long-term global economic growth**. Companies already are benefiting from increasing the efficiency of linear models, and new circular models designed to reduce resource use are generating significant value.

Investors benefit from understanding the business risks and opportunities posed by a resource-constrained world. This report offers an investor case for considering corporate materials and waste factors in the investment process and provides resources for businesses and investors to take next steps. Materials and waste factors, in addition to other environmental factors, can help forward-thinking investors incorporate both resilience and growth potential into their portfolios.

Key Takeaways:

I. **Global Backdrop – Global material demand and waste generation have increased to unprecedented levels, and overall resource price increases and recent price volatility are unlikely to abate.** Prices of key resources have risen in recent decades, all while significant value is lost through waste streams.

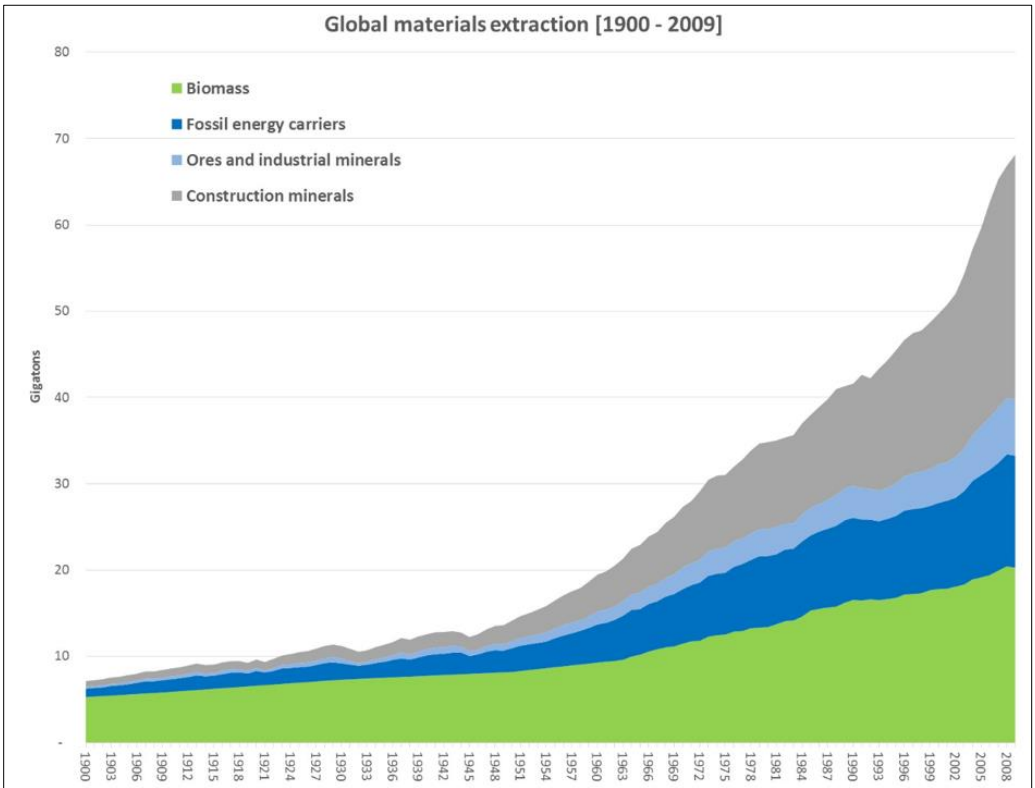
II. **Risks – Key risks are operational, reputational, and regulatory.** These risks have already materialized for certain companies, illustrating the financial danger for investors of business-as-usual corporate behavior.

III. **Opportunities – Companies can act upon and capture operational, strategic, and market opportunities related to materials and waste.** Investors can benefit from improved cost savings, resiliency to price volatility, and new markets for growth.

IV. **Actions for Investors – There is an increasing amount of resources and data available to investors for materials and waste analysis.** Using sector-specific materiality standards, corporate-disclosed materials, and waste data can help identify attractive investments.

I. Global Backdrop

Population growth and rising standards of living are putting unprecedented stresses on limited natural resource supplies around the world. By 2030, almost five billion people will make up the global middle class, up from two billion people in 2012, significantly increasing global consumption.[1] In 2015, G7 nations formed the "Alliance on Resource Efficiency," recognizing the unsustainable trends of material usage and waste generation. The G7 cited "**increasing business risks**" as a driver for action, including "**higher material costs, as well as supply uncertainties and disruptions.**"[2]



Source: Krausmann, F., Gingrich, S., Eisenmenger, N., Erb, K.H., Haberl, H., Fischer-Kowalski, M. Growth in global materials use, GDP and population during the 20th century. Ecological Economics 2009 (in press: doi:10.1016/j.ecolecon.2009.05.007)

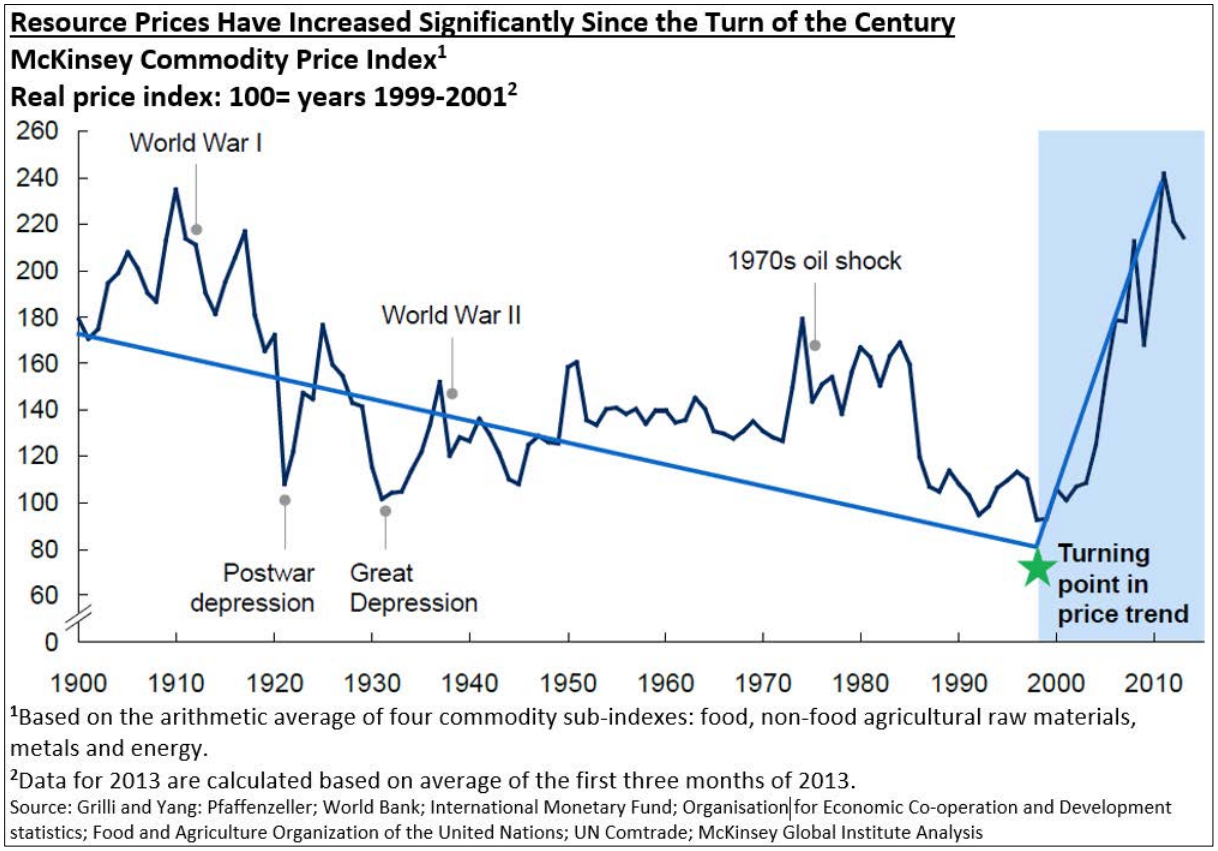
From 1970-2010, annual global material use grew by 300%.[3] With nearly 20% of raw materials ending up as waste, global waste generation is also on the rise.[4] Companies' material use and waste generation reflect this trend; overall waste generation has increased for both U.S. and global companies in recent years.[5]

The current model of material use is linear; materials are extracted, consumed, and unused resources are disposed of as waste. Most materials are sent to a landfill or incinerated after one product life cycle. **This represents a massive loss of value.**

- 95% of plastic packaging's material value ($80-$120 billion annually) is lost after one use.[6]

- In 2014, electronic waste materials included $52 billion of potentially reusable resources, but less than 17% is thought to have been recycled properly or reused.[7]
- Metals with relatively high recycling rates still lose substantial value through their waste streams. Annual lost value amounts to $52 billion for copper, $34 billion for gold, $15 billion for aluminum, and $7 billion for silver.[8]

Increasing material extraction and waste generation, coupled with poor resource recovery, poses **significant risks to businesses through price volatility**.



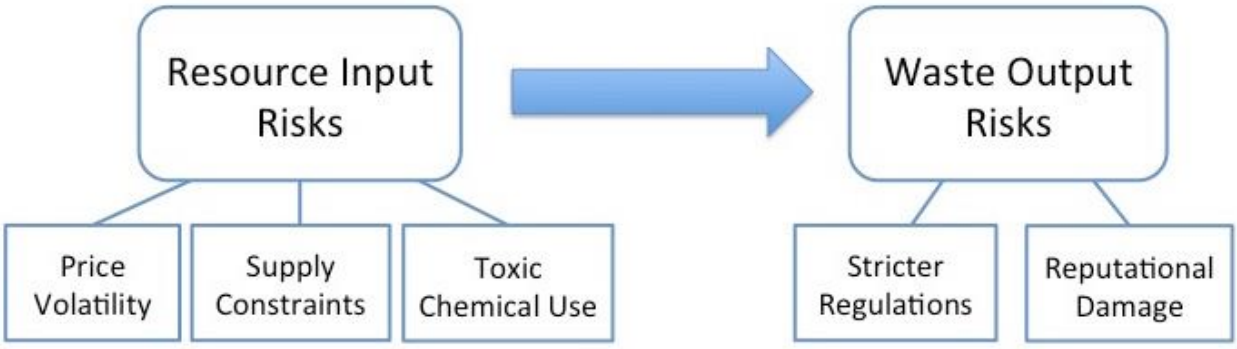
Commodity prices have fallen since 2014, amidst large amounts of volatility. Still, over the long term, increasing demand and a finite supply would suggest an upward price trend. A UNEP report projected that resource extraction would need to triple by 2050 (compared to 2000) under current development trends, and stated that this "**probably exceeds all possible measures of available resources**."[9] Under this scenario, the physical supplies of many resources are not in danger of disappearing altogether, but the economics of extraction would change drastically. Continued resource extraction would spread to increasingly costly and less-productive areas.

Investors should be mindful of the risks and opportunities driven by these trends, as companies better positioned for a resource-constrained world will hold advantages over competitors.

II. Materials and Waste Risks

Risks stemming from material inputs and waste outputs will increasingly affect a company's bottom line.

These risks manifest themselves both in resource inputs and waste outputs.



Investors should be mindful of three general categories of risk: **operational, regulatory, and reputational**.

Operational Risks

If a company uses resources inefficiently or is reliant on resources with unstable supplies, it increases its exposure to operational risks. This is not news to companies or investors, but potential resource constraints threaten business-as-usual operations. Even if companies have mitigated current exposure

to these risks, the continuing strain on resource supplies and enduring price volatility will carry more impact for companies that have not adapted proactively.

Recent resource price volatility has already spurred companies to improve material management:

- **GE Aviation** saw the price of rhenium (used as an alloy in jet engines) increase from $4,000/kg in 2006 to $6,600/kg in 2008. In response to this cost increase, GE embarked on a multi-year R&D project to use alternative materials, and boosted rhenium recycling programs.[10]
- In 2011, rising copper and oil prices created a $40-$50 million headwind for **United Technologies Corporation (UTC)**, a manufacturer of aircraft engines, elevators, HVAC, and other products. According to UTC's finance chief, the company had difficulty passing on higher resource costs to customers.[11]
- Tire manufacturer **Continental AG** highlighted a "higher than expected burden from increasing raw materials costs" in their Q3 2011 Earnings Call. The rising cost of synthetic rubber at the time, an increase of more than €900 million, was significantly higher than previously anticipated. Rare earth metal prices also burdened the group with additional costs totaling €50 million in the quarter. It was noted that the cost of dysprosium, used in magnets for electric motors, had risen nearly twentyfold over the prior 12 months.[12]

China's Rare Earth Elements Quota

A telling example of the operational risks of resource scarcity came in 2010, when China announced that it would significantly lower export quotas on rare earth elements (REE). At the time, China mined 95% of the world's REE, thus holding a **geographic monopoly on metals increasingly used in global products like smartphones, electric cars, and fluorescent lighting**.[13] The restriction caused the average price of REE to increase by as much as 750%[14] and forced companies to react quickly:

- **Hitachi**, reliant on REE for the production of motors and other products, announced a rare earth metal **recycling** program.[15]
- Motor producers like **Toyota** and **Tesla** worked to develop induction motors free of REE.[16]
- Turbine manufacturers, including **Siemens**, scrambled to find alternative sources of REE. Competitors like **Vestas** and **Enercon GmbH** had already **minimized usage** of rare earth metals to avoid dependence on strategic raw materials.[17]

By the time the quota was lifted in 2015, REE extraction in other parts of the world (and REE smuggling from China) had ramped up and mitigated the financial impacts of strict quotas.[18] However, this episode is instructive in illustrating that operational dependence on strategic resources with limited availability carries risks. Over time, supplies of more resources are likely to be stressed. Taking early initiative on resource efficiency can reduce the financial burden of spikes in resource prices.

Higher stresses on resource supplies are likely to arise as consumption increases, and companies that are proactive in reducing material use, improving reuse/recycling rates, and sustainably sourcing materials will be better positioned to withstand resource price volatility.

Regulatory Risks

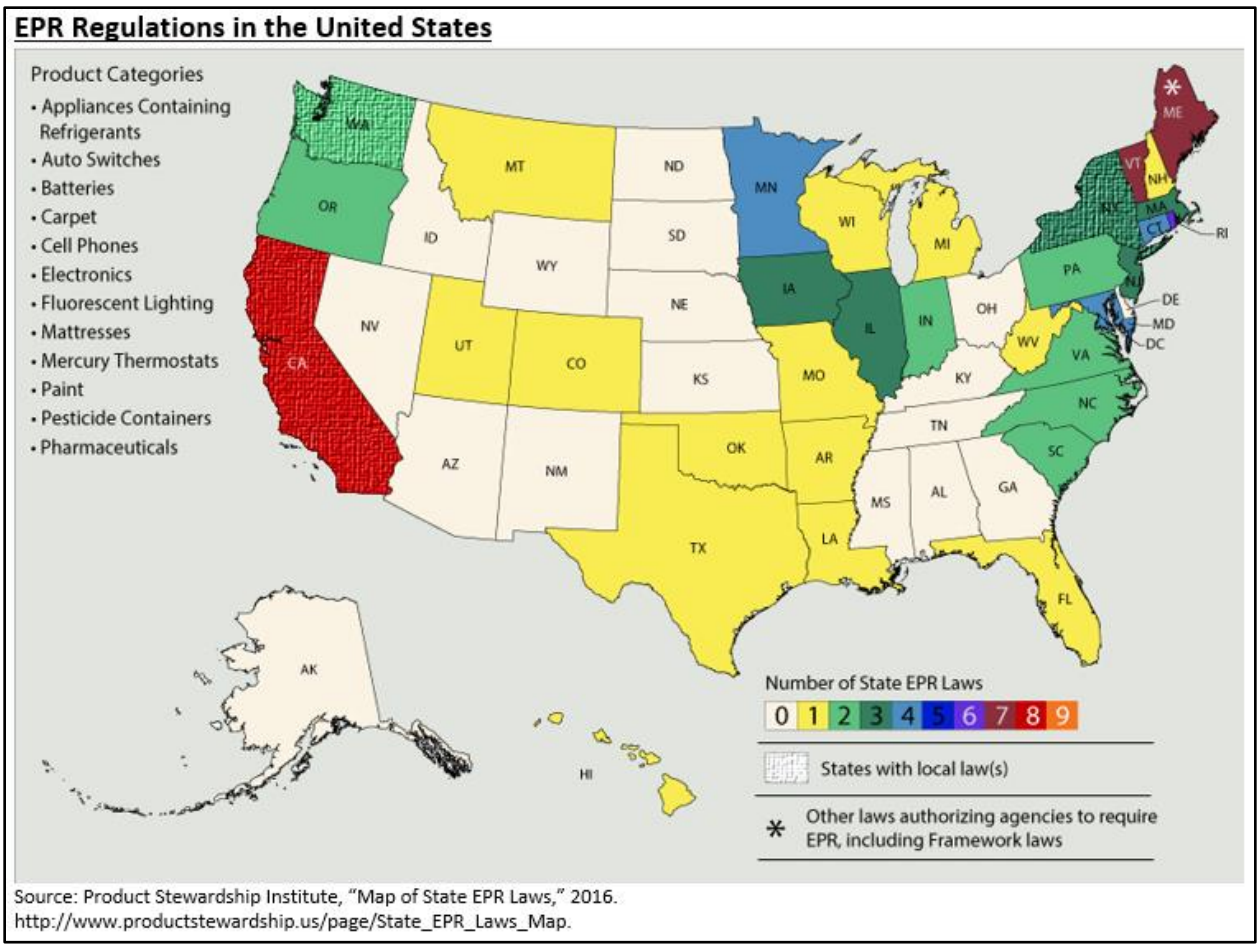
Regulations regarding corporate waste management are becoming more commonplace globally as well as more stringent; companies that do not measure and manage their waste can be exposed to regulatory retribution and financial damage.

Increasingly, companies are exposed to risks if they are unprepared for regulatory changes regarding their waste and materials management, some of which include:

1) Stricter legal requirements on hazardous waste disposal
2) More restrictions on materials used in products
3) Bans on wasteful packaging and/or harmful products

Regulations are increasingly being designed to shift material and waste management responsibility to producers instead of consumers.

- The 1976 **Resource Conservation and Recovery Act (RCRA)** is the foundational legislation governing waste management in the U.S. It sets a minimum federal standard on waste disposal and tasks **companies with cradle-to-grave management of both hazardous and non-hazardous solid waste.** Some states have implemented additional, more stringent regulations; for example, lawmakers in Rhode Island recently introduced **a bill requiring companies to recycle at least 80% of packaging by 2020.**[19]
- In December 2015, the European Commission passed a **Circular Economy package**. The new Action Plan provides funding and sets a common EU target for recycling 65% of waste by 2030, as well as simplifying, improving, and harmonizing definitions and calculation methods for recycling rates throughout the EU.[20]
- **Extended Producer Responsibility (EPR)** emerged in Northern Europe in the 1990s as a policy strategy that shifted costs of waste management from municipalities and taxpayers to firms. EPR laws now exist in 50 countries, including the entire EU, and in 32 U.S. states.[21]



Source: Product Stewardship Institute, "Map of State EPR Laws," 2016.
http://www.productstewardship.us/page/State_EPR_Laws_Map.

As global waste generation continues to increase dramatically, more countries are likely to pass regulations on waste disposal, often placing costs on producers. Companies have already faced retribution for non-compliance with **hazardous waste regulations**:

- In 2013, **Walmart** was fined **$82 million by the EPA for improperly dumping hazardous waste** from its California stores.[22] Only 5.68% of Walmart stores are in California; if these fines were scaled to the entire Walmart Corporation, it would be facing a $1.64 billion fine.[23]
- **Alpha Natural Resources** (the 2nd largest U.S. coal producer) paid a **$27.5 million fine - 2.5% of the firm's quarterly revenue figure at the time -** in March 2014 after toxic discharges from its mines polluted drinking water and violated hazardous material regulations. In order to follow the guidelines set by the RCRA, Alpha Natural Resources had to spend **$200 million to implement wastewater treatment systems**.[24]
- **Target** was fined $22.5 million in February 2011 after the EPA found that 290 Target stores throughout California disposed of hazardous materials, such as flammable liquids and toxic chemicals, at landfills not designated to receive them.[25] **Target stock price declined 6.3% versus a market decline of 1.9%**, over the following ten trading days after the announcement of the fine, effectively a $2.4 billion loss of value.

- In September 2015, the EPA and the Department of Justice announced a remedial action consent decree valued at $194 million with **Wyeth Holdings LLC**, a subsidiary of **Pfizer Corporation**. The company will perform cleanup work in New Jersey after years of improper chemical waste storage and disposal.[26]

E-Waste – A Growing Problem

The rapid proliferation of electronic equipment and devices has made electronic waste ("e-waste") the fastest growing waste stream on the planet.[27] Electronic products can contain toxic materials and may be difficult to disassemble for reuse/recycling, resulting in significant quantities of e-waste being landfilled or even exported for disposal in other countries. A range of environmental, health, and safety concerns are attracting increasing regulatory attention, and these concerns pose a growing risk for companies.

- Within the European Union, the **2003 Waste Electrical & Electronic Equipment (WEEE) Directive** both restricts the use of hazardous materials in electronic equipment, as well as incentivizes responsible recycling of e-waste by setting targets for collection, recycling, and reuse.[28] Producers and distributors of electronics **pay an annual fee** to fund the collection and recycling of e-waste.
- In the U.S., 27 states currently have e-waste recycling laws, and businesses that fail to comply pay a steep price. As of December 2015, both **Comcast and AT&T** had agreed to pay the state of California sums in **excess of $23 million** for their "careless and unlawful" e-waste disposal practices.[29]
- In July 2016, a bill introduced to the U.S. House of Representatives (HR5579) would put strict limits on exports of e-waste. This could impose sudden costs on companies accustomed to exporting e-waste. An investigation into **Dell**'s recycling of electronic devices found that 32.5% of devices sampled were exported.[30]

As e-waste continues to grow, government concerns likely will increase, and more countries could place regulations and fee burdens on companies.

Companies whose products can be affected by **waste-minimization regulations** also face regulatory risks. In FY2012, **Crown Holdings,** a packaging maker, stated in its Form 10-K, "A number of governmental authorities both in the U.S. and abroad also have enacted, or are considering, legal requirements relating to product stewardship, including mandating recycling, the use of recycled materials and/or limitations on certain kinds of packaging materials such as plastics. Such developments may reduce the demand for some of the Company's products, and/or increase its costs."[31]

In addition to regulations governing waste outputs, there are an increasing number of regulations regarding **material inputs**. Chemical substance regulations are growing faster than any other type of environmental regulation, and thousands of chemicals have been identified that could be included on restrictive Chemicals of

High Concern lists in the future. In the U.S., the recent reform of the Toxic Substances Control Act will shift the cost and burden of evaluating and regulating chemicals to manufacturers, while also imposing new fees. Companies unprepared for the increasing responsibilities of managing material inputs and waste outputs will be poorly positioned to compete with peers who are proactive in measuring and managing their exposure to a range of regulatory risks. Early-movers that can improve management of resource efficiency, hazardous outputs, and chemical inputs can mitigate these risks. Late-adopters can be exposed to high fees and taxes while needing to quickly implement costly programs to reduce waste or toxic material usage.

Reputational Risks

Materials and waste management each can have significant effects on a company's reputation, which in turn can materially impact a company's bottom-line. Corporate brand and reputational damage can lead to loss of market share and significantly lower revenues. Reputational risks surrounding materials and waste management are most likely to manifest as:

1) Toxic or hazardous chemicals being discovered in a company's products
2) Consumers perceiving a company's products to be wasteful and non-recyclable

Companies that fail to measure and responsibly manage the chemical composition of their products may be vulnerable to significant brand damage. A 2014 UNEP report stated that most sectors "do not have sufficient information systems in place to enable the exchange of chemical content information."[32] Yet the chemical content of products can have serious financial impacts:

- In March 2015, a "60 Minutes" report exposed unlawfully high levels of formaldehyde in laminate flooring from **Lumber Liquidators**. The company was subject to investigations, fines, and its **stock fell over 80%** from its peak in 2015.[33]
- When it came to light in 2008 that **SIGG USA**'s aluminum water bottles contained BPA (Bisphenol A), many retailers quickly pulled the water bottles from the shelves, and the company ultimately **declared bankruptcy** in 2011.
- **Johnson & Johnson** baby shampoo, a product deeply trusted by consumers, was found to **contain dangerous levels of chemicals** (formaldehyde and 1,4-dioxane) in 2009.[34] The backlash was particularly strong in China, where a survey of 120,000 consumers found 75% had stopped purchasing Johnson & Johnson products. In China's $14.8 billion baby-care market, Johnson & Johnson market share **dropped over 8%** (from 64.3% to 55.9%) from 2008 to 2010, approximately a $1.2 billion retreat.[35]

In addition to the material composition of products, companies must be mindful of the disposal of their products at the end of use. Consumers care about the environmental impacts of products, and waste disposal is tangibly perceptible to consumers.

The Risks of Products Perceived to be Wasteful

Keurig Green Mountain experienced rapid growth from 2008 to 2014, largely fueled by single-serve coffee brewing pods known as "K-Cups." By 2014, pod-based coffee machines had spread to nearly ⅓ of American households, and K-Cups drove most of Keurig Green Mountain's $4.7 billion yearly revenue.[36]

But concerns over K-Cup waste - until recently the pods were not recyclable - arose among consumers and ultimately had major effects on sales. Environmental advocates launched a #KillTheKCup campaign, and the criticism gained momentum across the media and consumers. Even though K-Cup disposal is a small fraction of Keurig Green Mountain's overall environmental footprint, the waste created by K-Cups was highly tangible and perceptible to consumers. In an interview, the inventor of K-cups even said he regretted inventing K-Cups because of the amount of waste generated.[37] These environmental concerns likely contributed to a slump in sales. Over 2015, Keurig's sales decreased 6%, and the stock price decreased almost 75% from a November 2014 high of $157.10 to a November 2015 low of $40.13, before it was acquired by JAB Holdings.[38] In 2016, the city of Hamburg, Germany, banned all single-use coffee pods due to their "unnecessary resource consumption and waste generation."[39]

Companies can anticipate and avoid reputational risks by designing more materially efficient and sustainable products. Consumers are increasingly environmentally-conscious. For example, a study commissioned by Tetra Pak found that 89% of consumers prefer to buy products in recyclable packaging.[40] Given increasing environmental awareness and the social media-enabled virality of consumer sentiment, the risks of wasteful products will only grow.

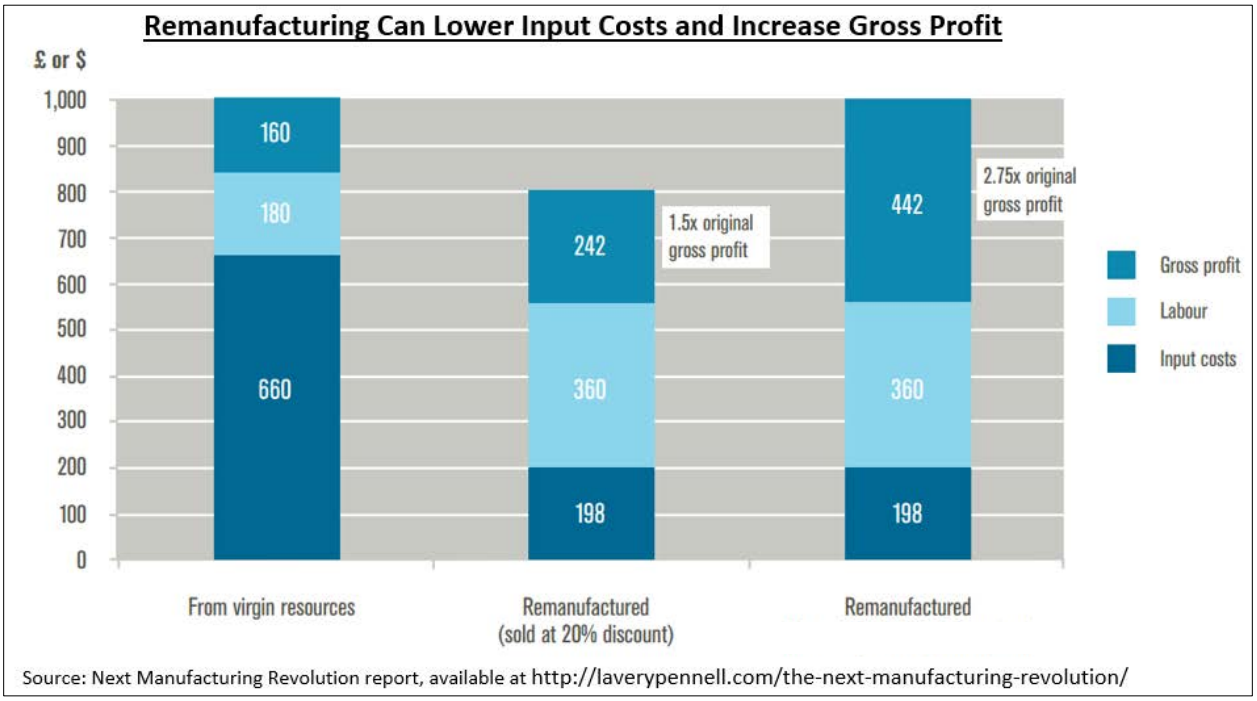
III. Materials and Waste Opportunities: Efficiency Drives Value

Increased corporate resource efficiency can yield a number of promising business opportunities. **Operational opportunities** can help companies reap significant cost savings by reducing their overall material use and diverting waste from landfills, and reuse/remanufacture/recycle programs can generate value from previously unutilized waste streams. **Strategic opportunities** abound as well, and more companies are starting to think in circular ways to reduce material use and spur growth. Finally, a number of exciting **market opportunities** will continue to arise for many materials, and changes in the waste management industry and reverse logistics will help facilitate improved resource efficiency.

Operational Opportunities

There is a clear business case for improving materials management and reducing the amount of waste sent to landfills. A 2000 University of Tennessee study found that waste minimization programs in manufacturing facilities improved operational efficiency and reduced cost while also providing environmental benefits for companies.[41] Waste disposal and material purchases are already direct costs

for businesses, therefore the financial opportunities presented by waste reduction are more direct and immediate than other environmental efficiency improvements.



Improving material efficiency through **reuse and recycling** programs can create revenue, reduce material expense, and lower waste disposal costs:

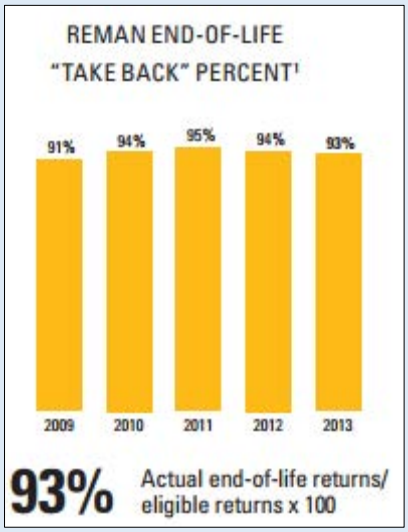
- In 2011, **Walmart** diverted 80% of its operational waste from landfills, and the program **returned $231 million** that year.[42] In FY 2016, the company saved $15.3 million through a program to optimize the size of the cardboard shipping cartons for apparel (saving 6.3 million pounds of corrugated cardboard, and using 8.1 million fewer boxes than in FY 2015).
- From 2007 to 2010, **General Motors**' waste reuse and recycling programs **generated $2.5 billion in revenue**. Byproduct reuse and recycling now generates almost $1 billion of revenue annually.[43]
- **P&G's** recycling program has **returned $2 billion** to the company since its initiation in 2008. Nearly half of P&G's global sites have achieved zero manufacturing waste to landfill.[44]

Apple – Mining Savings

Apple has taken an early stance as an industry leader in reducing/recycling e-waste, and these efforts have paid off. In 2015, the **company recovered $43.6 million in gold** from recycled devices. Overall, Apple **collected about 90 million pounds of e-waste in 2015,** which is equivalent to 71% of the total weight of the products sold seven years earlier. In an effort to further improve resource recovery, Apple unveiled Liam, a recycling robot (pictured top right) that can disassemble 1.2 million iPhones a year, a much higher efficiency than previous shredder technology. All of these initiatives have reduced Apple's demand for virgin materials, reduced expenses, and further stabilized raw material costs.[45]

Waste reduction programs have provided ongoing operational benefits to companies, and proactive companies will be better positioned to withstand price volatility and resource supply shocks.

Caterpillar – Remanufacturing Value



Caterpillar's Cat Reman program has helped the industrial equipment producer reduce the amount of materials it sends to landfills each year since its launch in 1973. The program is based on an exchange system where a customer returns a used component and receives a remanufactured product. Remanufactured products are equally as reliable as new products and are available at a fraction of the cost.

Cat estimates that 65% of their costs are material costs.[46] AS the Reman program minimizes waste output and the need for raw materials, it gives Cat a competitive advantage, especially in a resource-constrained future. From 2004 to 2014, the program salvaged 500,000 tons of materials, diverting them from landfills and returning them to use.[47] Today, Cat Reman operates in nearly all of Cat's industries and across four continents, employing more than 4,500 people, with 17 distinct facilities. The program recycles 60,000 tons of iron annually.[48]

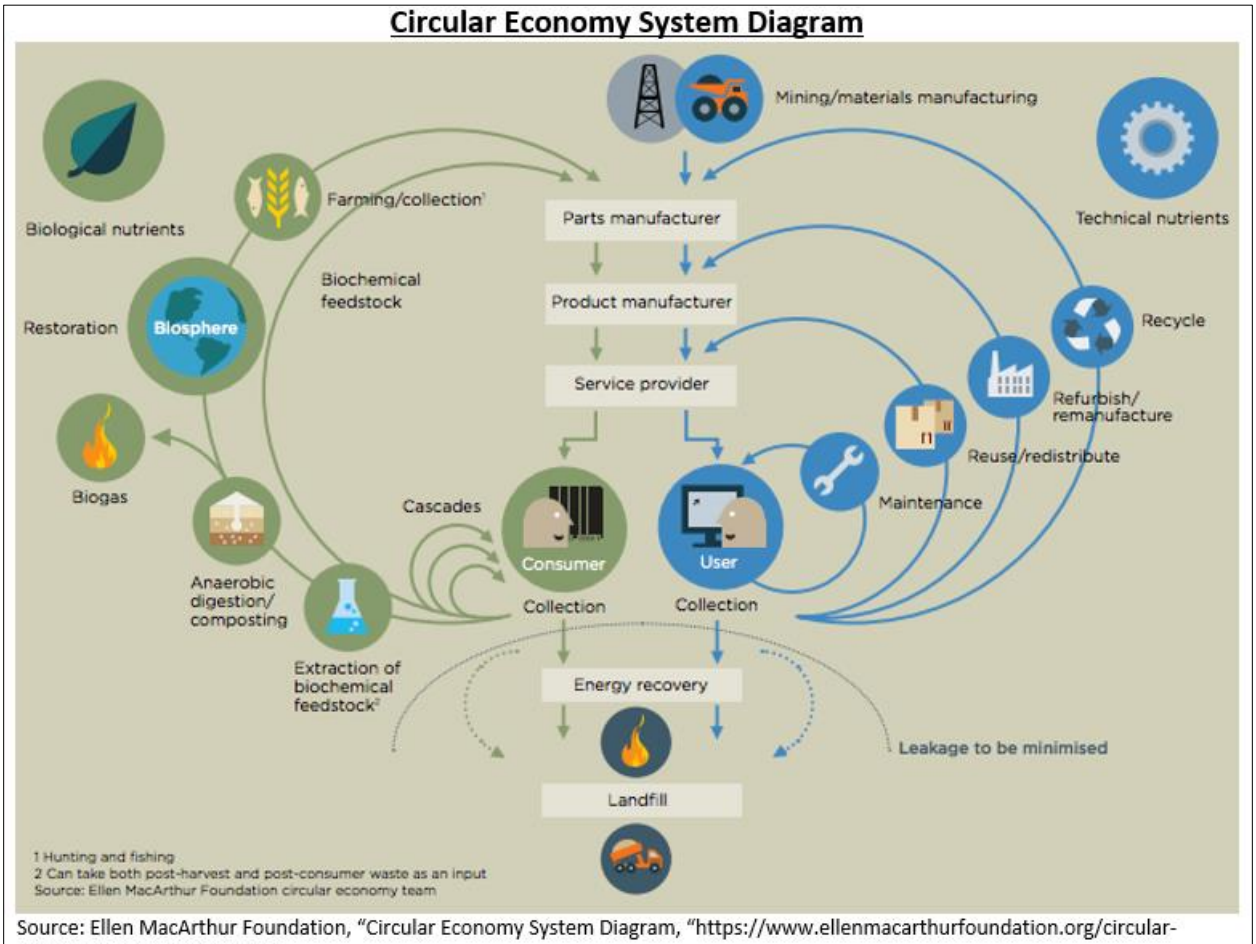
Reducing waste and material use can result in a number of cost savings. An industry expert and researcher at a large industrial company noted that in some cases, using waste materials to make new plastics saves energy, costing up to 85% less than using virgin materials.[49]

A wide range of operational opportunities present a compelling business case for companies to improve materials and waste management. Investors that consider the materials and waste intensity of companies can better understand opportunities for cost savings, value creation, and resiliency.

Strategic Opportunities

Improving material efficiency can also provide benefits that go beyond direct operations. Companies can boost resiliency and create new profit streams, as well as attract more customers and improve the hiring and retention of talent.

Perhaps the most transformative strategy to improving material efficiency and recovering value from waste is the **circular economy**. The Ellen MacArthur Foundation defines the circular economy as "**restorative and regenerative by design**, which aims to keep products, components and materials at their highest utility and value at all times."[50] Companies adopting circular economy principles can not only lower input costs and improve security of supply, but can also create new profit streams and business service offerings.



Source: Ellen MacArthur Foundation, "Circular Economy System Diagram, "https://www.ellenmacarthurfoundation.org/circular-economy/interactive-diagram.

The circular economic model involves a major rethinking and re-designing of fundamental supply chain and waste management processes. Notably, recycling is far from the most preferred method to generate value from spent materials. A heavy emphasis is placed on keeping materials and equipment intact to preserve value for as long as possible through maintenance, reuse/redistribution, and refurbishing/remanufacturing. If these avenues are not available, recycling can still be a valuable mechanism for turning outputs into inputs. Any final waste products will be sent to waste-to-energy plants and landfills.

Using circular economy principles, companies can follow a framework geared toward creating synergies between environmental and economic systems. In the EU alone, the circular economy could lead to an estimated $340-$630 billion per year in net cost savings.[51] Given that emerging economies often have higher levels of relative material intensity, the potential for savings could be even higher. Corporate circular economy strategies involve redesigning or developing new processes to maximize efficiency and recover value from waste streams:

- Since 2002, **IBM** has recovered more than one billion pounds of machines, parts, and materials, and has sold over 49 million parts after processing and harvesting. In 2014, IBM processed 32,000 metric tons of end-of-life products, 99.5% of which were diverted from landfills. That same year, IBM's global packaging team saved around 101.6 tonnes of packaging through product and packaging redesign. All told, from 1998-2007 IBM's environmental programs (waste efforts included) have saved the company more than $100 million.[52]
- **Interface Inc.** has partnered with Aquafil (its yarn supplier) and the Zoological Society of London (ZSL) to source recycled yarn from fishing nets in the Philippines. Local villagers collect discarded fishing nets, which are processed by Aquafil into recycled nylon and sold to Interface. In addition to improving the local economy and environment, this partnership helps Interface move toward its goal of 100% recycled content in its carpets.[53] The program is being expanded to Cameroon.
- **Maersk Line**, the world's largest container shipping company, is improving recycling efforts in an effort to reduce its input costs. Steel makes up the vast majority of the volume of container ships, and a steady and inexpensive supply of steel is critical to Maersk's success. Maersk recently created a detailed online database to identify recyclable components of decommissioned ships, which are taken apart at a shipbreaking yard in China. Recycled metals can be used as inputs for Maersk, or sold, creating a new revenue stream.[54]

Nike – Weaving a More Sustainable Future

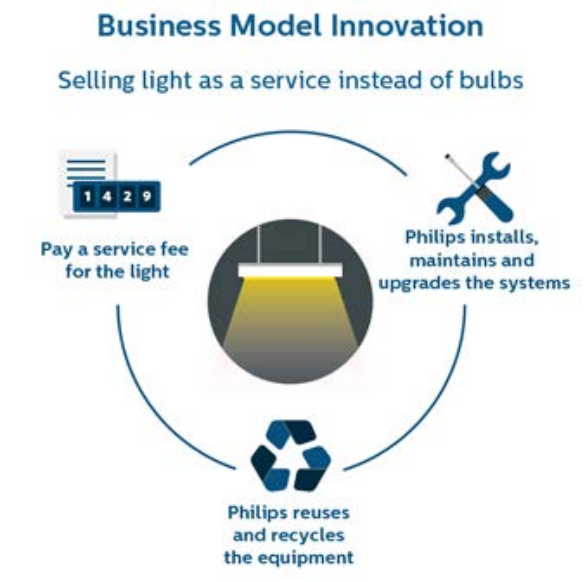
The global textiles industry has enormous environmental impact. As of 2009, the industry was estimated to consume nearly 1 billion kWh of electricity annually as well as several dozen gallons of water per pound of textiles.[55] Nike is working to change that reality by improving material recycling. As of early 2016, 71% of Nike's footwear is made with materials recycled from its own manufacturing process. Nike's *Flyknit* technology (pictured above),

which it employs in the majority of its footwear areas, reduces material usage by up to 20%, while also cutting labor costs, reducing production time, and boosting profit margins.[56]

Nike says that on average, *Flyknit* **produces 60% less waste than traditional cut and sew shoe manufacturing, enabling Nike to avoid nearly 3.5 million pounds of waste since 2012.**[57]

Creative ways of improving material efficiency have provided continual strategic benefits to companies, and proactive companies will be better positioned to compete as products, services, and markets themselves are redefined by increasing resource constraints.

Philips Uses "Product-as-a-Service" to Create Circular Model



Some companies are incorporating circular economy principles through a "Product-as-a-Service" model. In this model, the consumer purchases a service, while the company manages the full life cycle of the product from production to disposal. Companies are incentivized to create more innovative, durable, and sustainable products, increasing cost efficiency and decreasing waste.

Philips Lighting has pioneered this model with its "Pay Per Lux" strategy. Philips maintains ownership of the lighting equipment (and pays the electricity bill), while customers pay by the lumen; in this way, Philips has a financial incentive to develop an energy-efficient, long-lasting system. Philips has since implemented "lighting-as-a-service" in several locations, including a ten-year contract with the Washington Metropolitan Area Transit Authority. LED technology enables Philips to achieve "much lower maintenance and operating costs."[58]

Philips also uses service-based models for medical imaging devices used in hospitals. Hospitals save by only paying for the device when its use is needed, and Philips profits because a single device can be in constant use as different hospitals require it at different times.[59] According to CEO Frans van Houten, Philips Healthcare's leasing business is already worth €200 million.[60]

Companies have real incentives to engage in the shift to a circular economy, both in terms of mitigating risks and capitalizing on opportunities. Circular strategies can save money and lead to breakthrough innovations, while also appealing to potential customers and workers. Product take-back programs[61]

and Product-as-a-Service models both expand companies' points of interaction with customers, leading to improved possibilities for customer loyalty and retention.

There is also an increasing public demand for companies to address issues of sustainability, and waste and material efficiency measures are some of the most visible for customers and employees. A 2010 **PwC survey found that around 89% of survey participants wanted products with an environmental benefit.**[62] This demand similarly translates to employees, as an increasing number of **businesses are citing performance on sustainability issues as an important factor for attracting and retaining talent.**[63] Across the globe, more and more young employees (ages 21-30) are taking pay cuts or making career choices to work for more sustainable companies.[64] Waste and material efficiency measures have been cited as improving employee engagement and buy-in. These trends highlight the strategic benefits of being more materially efficient from both a customer and employee perspective.

Market Opportunities

Mounting demand for solutions to recycle, reuse, resell, or even eliminate material waste is affecting businesses across all sectors and creating market opportunities from which investors can benefit. A 2011 study by McKinsey identified opportunities to increase resource productivity that would result in $2.9 trillion of annual savings.[65] A large quantity of these benefits lie in new or improved markets. Market opportunities in waste and materials management stem from movement toward higher resource efficiency and a more circular economy.

Recycling Infrastructure

In the U.S. alone, over 50% of waste generated is sent to landfills, and close to 80% of that landfilled material could have been recycled.[66] Industry analysts estimate that $1.25 billion is needed to fully modernize American recycling infrastructure.[67] Globally, with a projected 5.2 billion middle and upper class consumers spending over $3,650/year by 2030, large amounts of capital will need to be deployed to update and expand waste recycling/management infrastructure.[68]

The private sector will play a major role as more companies move toward circular models. **Novelis**, the world's largest recycler of aluminum, spent $2 billion in capital investments from 2011-2015 in anticipation of the growing demand for premium aluminum. Producing aluminum from recycled scrap rather than through mining and refining reduces energy consumption by over 90%, which lowers costs and reduces price volatility.[69] **Republic Services** and **Waste Management** have both set targets for adding recycling infrastructure, and the increase in commodity prices will make recycling-related investments more attractive.

Outside of the waste management sector, other companies are also recognizing that improving overall recycling capabilities will increase the amount of recycled material available for purchase. A variety of stakeholder-funded organizations such as **The Closed Loop Fund** and **The Recycling Partnership** have sprung up in the past few years to further implement circular partnerships. Motivation from within and

outside the waste management sector to improve recycling infrastructure can drive market opportunities, particularly if commodity prices begin to rise again.

Waste-to-Energy Market

Outside of material recycling, one of the fastest growing segments of the landfill diversion market is waste-to-energy treatments. The global waste-to-energy market is expected to reach $37.64 billion by 2020, growing at a compound annual growth rate of 5.9%.[70] **In 2013, Waste Management generated almost as much energy as the nation's entire solar industry at the time by using various methods for creating energy from refuse.**[71] By reducing greenhouse gas emissions from trash hauling and landfilling, these treatments have relatively high environmental benefits compared to landfills. **Covanta**, which operates 45 waste-to-energy facilities in North America, China, and Europe, slashed carbon emissions at its facilities by 18.2 million metric tons in 2014, while reducing landfill intake by 20.7 million metric tons.[72] As more companies and countries seek to divert waste from landfills, waste-to-energy plants will likely be an area of continued growth.

Reverse Logistics

"Reverse logistics" refers to the process of transporting goods and materials from their typical final destination, with the purpose of capturing value or proper disposal.[73] For the circular economy to take shape between companies, reverse logistics will be required to **connect waste producers with manufacturers who can use output materials as inputs.** Both well-established companies and startups are exploring opportunities to meet these needs.

DHL and **UPS** have each sponsored reports detailing the transition to a circular economy, and both companies could play a major role in material transport. UPS currently provides logistics for **TerraCycle**, a company that recycles and repurposes post-consumer waste. **Optoro**, a startup, offers a software platform that allows retailers to manage and sell excess inventory.

There are also new **virtual marketplaces** aimed at facilitating the resale of materials between companies. One example, **The U.S. Materials Marketplace**, launched in July 2015**.** In the initial three months, 23 companies across 12 sectors participated, representing over $600 billion in annual revenue. Transactions through the online platform presented value to both buyers and sellers. One ongoing transaction for bauxite residue from cement co-processing was worth roughly $40 million per year in disposal/storage savings and value creation.[74]

Further improvements in reverse logistics will be necessary to facilitate the material flows of a circular economy, creating significant growth potential in this area.

Investors that consider the operational, strategic, and market opportunities of improved material efficiency will be able to capture financial benefits overlooked by others.

IV. Recommended Investor Actions

Investors can reap rewards, capture opportunities, and reduce risks by considering companies' waste generation and material efficiency in their investment analysis. **The first step to incorporating this data into investment processes is requesting improved company data disclosure.**
Shareholders can and should take part in asking companies to report material flows and waste streams throughout both their operations and their upstream and downstream supply chains. At present, publicly-disclosed corporate waste data is relatively sparse, and significant improvements are needed for this data to be truly actionable across the board for investors. Many companies are reluctant to disclose material use and waste generation data out of proprietary concerns and fear of increased regulation. Additionally, investor interest is not yet cohesive enough to outweigh these concerns. Greater awareness and attention from investors on these issues can help spur improved disclosure.

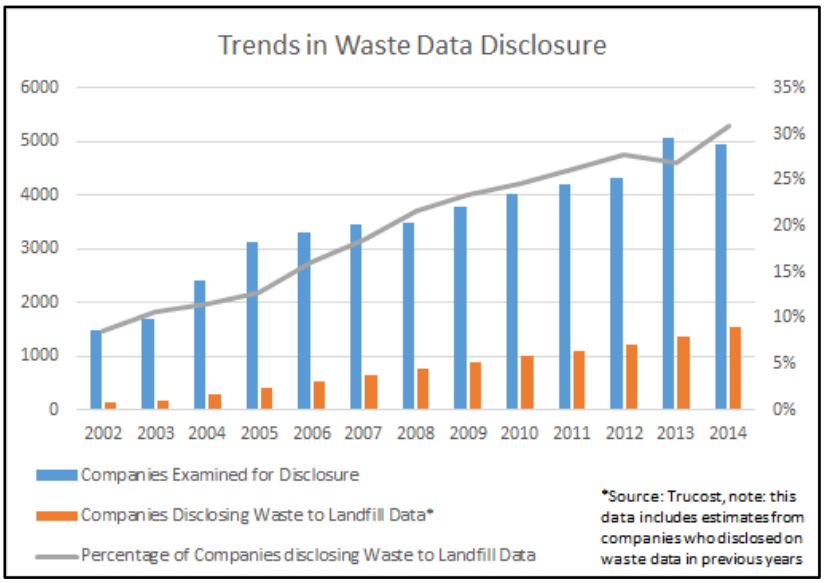
However, there is already growing recognition in the financial community of the importance of resource efficiency. For example:

- In addition to Terra Alpha Investments, LLC, some institutional equity investors are expressing support for considering companies' material efficiency and/or waste management performance, including Norges Bank Investment Management.
- Leading private equity firms, including Carlyle Group and KKR, already expect their portfolio companies to assess their waste and seek to improve their material efficiency.[75]
- A 2013 study by PwC found that 71% of private equity investors surveyed considered environmental factors in their due diligence at acquisition.[76] A PwC survey the following year found that 82% of investors said they considered resource scarcity and climate change in the past 12 months, and 87% expected to within the next three years.[77]
- In 2010, the SEC issued guidance on climate change risk disclosure, warning that "changes in the availability or quality of natural resources" could have "material effects on companies." As of June 2016, the SEC Investor Advisory Committee acknowledged that a "growing number of investors utilize sustainability and environmental disclosures"[78] to better understand the long-term financial outlook of a company.

Resources and Data

Resources/organizations that focus on material efficiency and waste stream risks and opportunities from an investor perspective are listed in Appendix A. The Sustainability Accounting Standards Board (SASB) has developed industry-specific sustainability accounting standards to assist public corporations with disclosing material information, including resource efficiency-related data, to investors.

Where does an investor look for information about a company's material efficiency? Currently, over 1,023 global public companies disclose some level of corporate-wide information about their waste generation and recycling habits. The number of companies reporting this information has been increasing each year.



1,023 Companies Reported Some Metric on Waste in 2014	
Industry	**Company Count**
Industrials	237
Consumer Goods	141
Basic Materials	134
Financials	127
Consumer Services	96
Utilities	75
Oil & Gas	68
Healthcare	60
Technology	59
Telecommunications	26

Source: Trucost

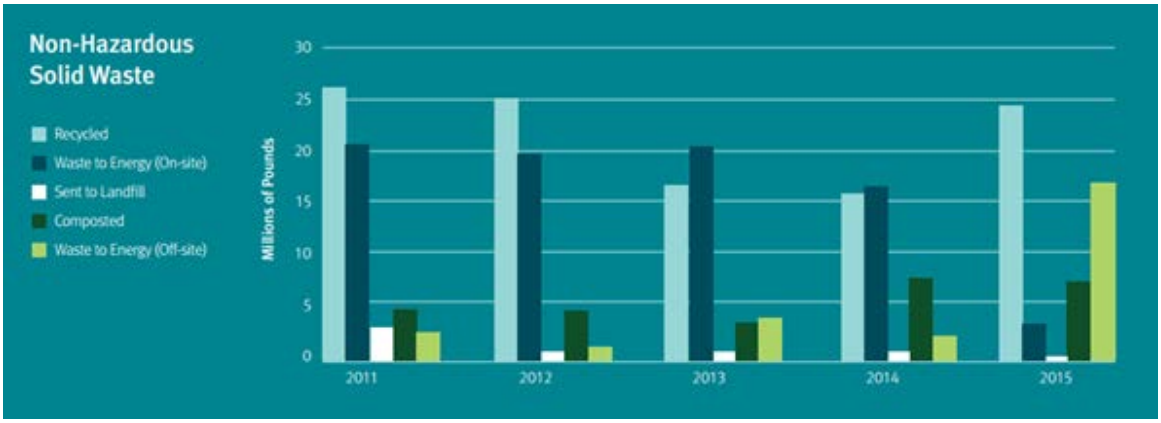
Disclosed data commonly can be found through a few channels:

- A company's own public reports (e.g., annual reports and sustainability reports).
- Third party data repositories (e.g., Trucost, Global Reporting Initiative (GRI), Bloomberg's ESG section, and Thomson Reuters).

Examples of Good Practices in Materials Management and Disclosure

Herman Miller – Material Efficiency Boosts Performance

Herman Miller is an American furniture manufacturer serving markets worldwide. They have been publishing a sustainability report since 2006 and their products are all largely focused on themes surrounding: material savings, energy efficient manufacturing, recycled/recyclable content, and zero toxicity. As part of their report, they disclose waste statistics such as tonnes of non-hazardous waste recycled, converted to energy, sent to landfills, and composted.



Below is a snapshot of the company's waste data available on a Bloomberg Professional:

ADJ Herman Miller Inc — Periods 10 Annuals — Currency USD

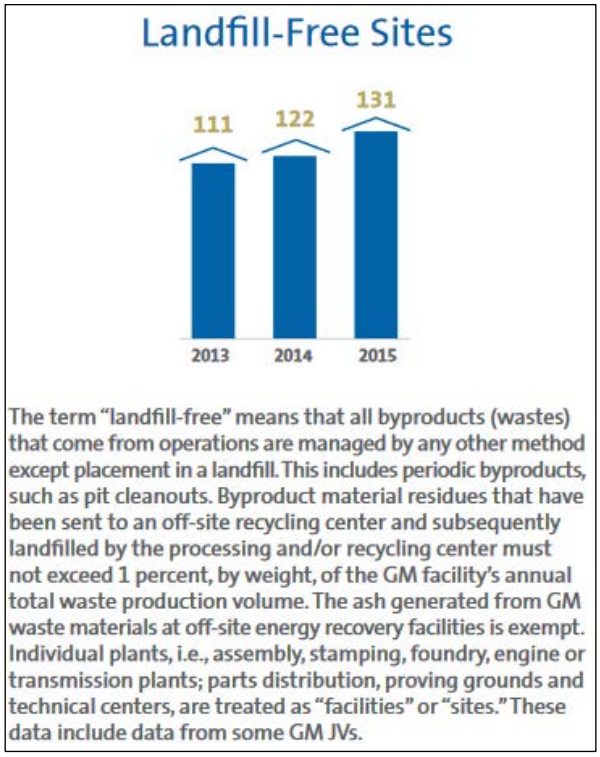
In Millions of USD except Per Share	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
12 Months Ending	05/29/2010	05/28/2011	06/02/2012	06/01/2013	05/31/2014	05/30/2015
Total Waste	1.1	1.3	0.5	–	0.3	0.2
Hazardous Waste	0.0	0.0	0.0	–	–	–
Waste Recycled	–	–	–	–	–	–
Waste Sent to Landfills	1.1	1.3	0.4	–	–	–

Despite its growing market capitalization, revenues, and earnings per share over the past decade, Herman Miller has steadily seen its total waste generation and waste sent to landfills decline. This improving level of efficiency is also demonstrated in its fundamentals, as Herman Miller has noticeably lower costs of operation than the majority of its peers.

Name (BICS Best Fit)	Curr Adj Mkt Cap	COGS/Net Sales:Q	GM:Q	Return on Invested Capital	Return on Assets	Return on Equity
Average	3.80B	70.30%	29.70%	11.01%	6.50%	18.61%
HERMAN MILLER INC	1.93B	61.35%	38.65%	19.50%	11.29%	28.74%
HNI CORP	2.24B	62.93%	37.07%	14.24%	8.50%	23.77%
STEELCASE INC-CL A	1.72B	68.03%	31.97%	16.73%	10.21%	23.78%
KNOLL INC	1.23B	62.14%	37.86%	14.04%	7.66%	27.25%
ARMSTRONG FLOORING ...	527.38M	83.40%	16.60%	--	--	--
GUANGDONG SACA PREC...	696.44M	77.85%	22.15%	7.34%	6.04%	9.84%
OKAMURA CORP	1.11B	67.40%	32.60%	6.36%	4.27%	8.59%
MAISONS DU MONDE SA	962.81M	--	--	--	--	--
LEGGETT & PLATT INC	7.08B	75.11%	24.89%	18.06%	11.19%	31.37%
NEWELL BRANDS INC	23.38B	61.55%	38.45%	6.18%	3.07%	19.39%

General Motors - Making Landfill-Free a Reality

Below is a snapshot of the waste disclosure section from General Motor's 2015 Sustainability Report. GM has been a corporate leader in reducing and reporting their waste intensity, as evidenced by the statistics highlighting GM's 22% waste intensity reduction over the past six years. Additionally, GM is on track to be operating 150 landfill-free facilities by 2020 (100 manufacturing and 50 non-manufacturing). *For assurance statement see Appendix B.*



The term "landfill-free" means that all byproducts (wastes) that come from operations are managed by any other method except placement in a landfill. This includes periodic byproducts, such as pit cleanouts. Byproduct material residues that have been sent to an off-site recycling center and subsequently landfilled by the processing and/or recycling center must not exceed 1 percent, by weight, of the GM facility's annual total waste production volume. The ash generated from GM waste materials at off-site energy recovery facilities is exempt. Individual plants, i.e., assembly, stamping, foundry, engine or transmission plants; parts distribution, proving grounds and technical centers, are treated as "facilities" or "sites." These data include data from some GM JVs.

*All manufacturing commitments use 2010 as a baseline and are working toward 2020 goals.

Total waste includes all byproducts that are generated as a result of daily manufacturing operations. This definition includes metal scrap and foundry sand, and excludes reused waste, construction, demolition and remediation debris. For 2012, a comprehensive global review of waste management classifications identified some instances where closed-looped recycling and other forms of recycling were misidentified as reuse, resulting in an adjustment of previously reported data.

In the report, GM reported on total waste generation for the past five years, as well as provided a projection for their 2020 target. GM also defined and reported on the progress made in converting facilities to "Landfill-Free Sites." GM broke this statistic down into separate disposal methods in accordance with GRI's G4-EN23 standard (see below).

Effluents and Waste	DMA	Operational Impact
G4-EN23	Includes hazardous and nonhazardous waste from manufacturing operations and some nonmanufacturing and JV facilities, excluding event waste from construction, demolition and remediation. Event waste is recycled to the greatest extent possible and tracked separately. Waste figures may also include vendor tooling used to produce proprietary GM parts. Total weight of waste by type and disposal method.	

Disposal Method	In k-tons to the nearest whole number
Reuse	41
Recycling	1,991
Composting	4
Recovery, including energy recovery	154
Incineration (mass burn)	13
Deep well injection	—
Landfill	268
On-site storage	Minimal
Other (includes microwaving, enclaves, plasma processing and other treatments)	20

V. Conclusion

- Patterns of global growth, material extraction, and waste generation point to an i**ncreasingly resource-constrained future**.
- Portfolios containing **resource-efficient** and **forward-thinking** companies will be **better positioned for long-term resiliency and success**.
- **Operational risks**, **regulatory risks**, **and reputational risks** for companies have already manifested and will continue to grow**.** Investors' **portfolios are inherently exposed to these risks.**
- Opportunities exist amidst these risks; many companies have already reaped **operational benefits** and **cost savings** through **resource efficiency initiatives.** Companies are also incorporating **circular economy** principles to eliminate waste, recover value, and seize **strategic opportunities**.
- Global efforts for waste reduction and value recovery will create **market opportunities**, both for specific materials and for general material efficiency improvements.
- Corporate data on waste and materials management can provide investors with **meaningful metrics to assess vulnerability and opportunity**. Currently, disclosure of materials and waste data is not robust. Investors need to request **improved disclosure** from companies **to gain better insight** into corporate materials and waste management.

Material efficiency will become even more important for bottom-lines and portfolios in an increasingly resource-constrained world.
Corporate data disclosure needs to improve to give investors actionable information.
Accounting for risks and identifying opportunities related to materials and waste management can enhance investors' portfolio decision-making.

Appendix A

Targeted Toward Companies	Targeted Toward Investors	Measuring Tool	Disclosure Tool

	Bloomberg	Bloomberg
Bloomberg, accessible on their business information terminals, has a robust ESG category of information for each company that discloses environmental, social, and governance information.		
	The Chemical Footprint Project	cfp the chemical footprint project
The Chemical Footprint Project provides a tool for companies to evaluate their management of Chemicals of High Concern (CoHC) in products. It surveys leading companies regarding their management strategy, chemical inventory, footprint measurement, as well as public disclosure and verification. It also produces an annual report with collected data. Investors can become signatories.		
	Climate Disclosure Standards Board	CDSB Climate Disclosure Standards Board
Climate Disclosure Standards Board (CDSB) is an international consortium of business and environmental NGOs. They offer companies a framework for reporting environmental information with the same rigor as financial information. This helps them to provide investors with decision-useful environmental information via the mainstream corporate report, enhancing the efficient allocation of capital.		
	Ellen MacArthur Foundation	ELLEN MACARTHUR FOUNDATION Rethink the future
The Ellen MacArthur Foundation is a charity dedicated to accelerating the transition to the circular economy. They conduct research, write reports, host events, and work with companies and governments to develop and implement circular economy initiatives.		

	Food Loss and Waste Protocol (FLW Protocol)	Food Loss + Waste PROTOCOL

The FLW Protocol was created by a multi-stakeholder partnership in order to develop an internationally accepted accounting and reporting standard on food loss and waste (the FLW Standard). The FLW Standard will enable stakeholders to measure and report their food loss and waste, and thus address how to reduce it.

	Global Recycled Standard; Textile Exchange	Global Recycled Standard

The Global Recycled Standard (GRS) is intended for companies that are making and/or selling products with recycled content. The standard applies to the full supply chain and addresses traceability, environmental principles, social requirements, and labeling. Developed with the textile industry in mind, the GRS may also be applied to products from any industry.

	Global Reporting Initiative (GRI)	Global Reporting Initiative™

GRI is an international independent organization aimed at empowering decision makers to create a more sustainable economy. GRI's Sustainability Reporting Standards are one of the world's most widely used standards on sustainability reporting and disclosure.

	How2Recycle	How2Recycle

How2Recycle seeks to increase the availability and quality of recycled material by creating a labeling system that improves package recycling. Currently over 50 companies and brands are participating.

	International Integrated Reporting Council (IIRC)	IR

The IIRC works to develop the International Integrated Reporting Framework through which companies can report integrated information about strategy, governance, performance and future prospects. The Framework explains the underlying concepts behind integrated reporting and provides guidelines.

	Plastic Disclosure Project	

The Plastic Disclosure Project surveys companies about their plastic footprint, encourages efficiencies in plastic use, and supports annual disclosure of corporate plastic data.

	Sustainable Electronics Recycling International (SERI)	

Sustainable Electronics Recycling International (SERI) is a non-profit focused on the reuse, repair, and recycling of e-waste. SERI administers a standard for the electronics recycling industry and works to raise international awareness of e-waste recycling issues.

	Sustainability Accounting Standards Board (SASB)	

SASB provides industry-specific insight on which sustainability factors are most important to companies and most material for investors. Through these industry standards, companies can tailor sustainability initiatives to maximize value, while also disclosing information more effectively to investors.

	Sustainable Packaging Coalition (SPC)	

The Sustainable Packaging Coalition is an industry working group that works to collaboratively build packaging systems that encourage sustainable material flows and financial prosperity.

	Trucost	

Trucost is a third party data aggregator that combines environmental data disclosure from other disclosure sources as well as individual company reports.

	**Task Force on Climate-related Financial Disclosures**	TCFD
The Task Force on Climate-related Financial Disclosures aims to help companies disclose their climate risk information in a clear and consistent way.		
	**Thomson Reuters**	THOMSON REUTERS
Thomson Reuters offers a comprehensive ESG database containing information on 4,000+ global companies and over 500+ data points, including all exclusion (ethical screening) criteria and all aspects of sustainability performance.		
	**U.S. Zero Waste Business Council (USZWBC)**	U.S. zero waste BUSINESS COUNCIL
The U.S. Zero Waste Business Council educates, informs, and documents the performance of Zero Waste Business. By improving efficiency and managing risk, the USZWBC aims to help companies generate economic and environmental value.		

Appendix B

GM 2015 Sustainability Report Assurance Statement

ASSURANCE

For 2015, GHD conducted an independent review for limited assurance on waste, water, carbon and energy data for global facilities. See page 152 for GHD's full statement of assurance. Due to limited assurance on most material data streams within the report, neither the GM Board of Directors nor senior management is involved in seeking assurance for the report.

End Notes

[1] Mario Pezzini, "An emerging middle class," *OECD Observer*, 2012. http://www.oecdobserver.org/news/fullstory.php/aid/3681/An_emerging_middle_class.html.

[2] "Annex to the G-7 Leaders' Declaration," *White House Office of the Press Secretary*, June 8, 2015. https://www.whitehouse.gov/the-press-office/2015/06/08/annex-g-7-leaders-declaration.

[3] "Global Material Flows and Resource Productivity," *UNEP*, July 2016. http://unep.org/documents/irp/16-00169_LW_GlobalMaterialFlowsUNEReport_FINAL_160701.pdf.

[4] "Material Resources, Productivity, and the Environment," *OECD*, 2013. http://www.oecd.org/greengrowth/MATERIAL%20RESOURCES,%20PRODUCTIVITY%20AND%20THE%20ENVIRONMENT_key%20findings.pdf.

[5] "State of Green Business Report 2016," *Greenbiz* and *Trucost,* January 2016. https://www.greenbiz.com/report/state-green-business-report-2016.

[6] "The New Plastics Economy: Rethinking the Future of Plastic," *Ellen MacArthur Foundation*, January 19, 2016. https://www.ellenmacarthurfoundation.org/assets/downloads/EllenMacArthurFoundation_TheNewPlasticsEconomy_15-3-16.pdf.

[7] "The Global E-Waste Monitor 2014: Quantities, Flows, and Resources," *United Nations University*, 2015. http://i.unu.edu/media/ias.unu.edu-en/news/7916/Global-E-waste-Monitor-2014-small.pdf.

[8] "Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition," *Ellen MacArthur Foundation*, January 25, 2012. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf.

[9] "Decoupling Natural Resource Use and Environmental Impacts from Economic Growth," *United Nations Environment Programme*, 2011. http://www.unep.org/resourcepanel/decoupling/files/pdf/Decoupling_Report_English.pdf.

[10] "Rhenium Reduction Program: Using Less of a Rare Material," *GE Citizenship*, 2011. https://web.archive.org/web/20110521001338/http://citizenship.geblogs.com/rhenium-reduction-program-using-less-of-a-rare-mineral.

[11] John Shipman and Anjali Cordeiro, "Dilemma Over Pricing," *The Wall Street Journal*, October 21, 2010. http://www.wsj.com/articles/SB10001424052702304741404575564400940917746.

[12] Martin Kahl, "Purchasing: The Impact of Rising and Volatile Raw Materials Prices, *AutomotiveWorld.com*, November 7, 2011. http://www.tpt.com/resources/docs/articles/AutomotiveWorld.com__Impact_of_rising_and_volatile_raw_material_prices.pdf.

[13] Keith Bradsher, "China to Tighten Limits on Rare Earth Exports," *The New York Times*, December 28, 2010. http://www.nytimes.com/2010/12/29/business/global/29rare.html.

[14] Nicola Jones, "A Scarcity of Rare Metals Is Hindering Green Technologies," *Yale Environment 360*, November 18, 2013. http://e360.yale.edu/feature/a_scarcity_of_rare_metals_is_hindering_green_technologies/2711/.

[15] Jason Clenfield, Mariko Yasu, and Stuart Biggs, "Hitachi Recycles Rare Earth as China Crimps Supply," *Bloomberg,* December 8, 2010. http://www.bloomberg.com/news/articles/2010-12-08/hitachi-recycles-rare-earth-as-china-crimps-supply.

[16] Alan Ohnsman, "Toyota Readying Electric Motors That Don't Use Rare Earths," *Bloomberg*, January 14, 2011. http://www.bloomberg.com/news/articles/2011-01-14/toyota-readying-electric-motors-that-don-t-use-rare-earths.

[17] Sally Bakewell, "Siemens Seeks Rare Earths Outside China After Supplies Curbed," *Bloomberg*, June 22, 2011. http://www.bloomberg.com/news/articles/2011-06-22/siemens-seeks-rare-earths-outside-china-after-supplies-curbed.

[18] Chuin-Wei Yap, "China Ends Rare Earth Export Minerals Quotas," *The Wall Street Journal*, January 5, 2015. http://www.wsj.com/articles/china-ends-rare-earth-minerals-export-quotas-1420441285.

[19] "Rhode Island House Bill 5508," *Rhode Island House of Representatives*, February 12, 2015. http://webserver.rilin.state.ri.us/BillText/BillText15/HouseText15/H5508.pdf.

[20] "Circular Economy Strategy," *European Commission*. http://ec.europa.eu/environment/circular-economy/index_en.htm.

[21] "Extended Producer Responsibility," *Recycling Today*, December 14, 2011. http://www.recyclingtoday.com/article/rt1211-extended-producer-responsiblity/.

[22] Stephanie Clifford, "Wal-Mart is Fined $82 Million Over Mishandling of Hazardous Wastes," *The New York Times*, May 29, 2013. http://www.nytimes.com/2013/05/29/business/wal-mart-is-fined-82-million-over-mishandling-of-hazardous-wastes.html.

[23] "Our Locations," *Wal-Mart*. http://corporate.walmart.com/our-story/locations/united-states#/united-states/california.

[24] Sophia Pearson, "Alpha Natural Resources Agrees to $27.5 Million Fine," *Bloomberg*, March 5, 2015. http://www.bloomberg.com/news/articles/2014-03-05/alpha-natural-resources-agrees-to-27-5-million-fine.

[25] Joel Rosenblatt, "Target to Pay 22.5 Million to Settle San Diego Waste Case, Official Says," *Bloomberg*, March 3, 2011. http://www.bloomberg.com/news/articles/2011-03-03/target-to-pay-22-5-million-to-settle-san-diego-waste-case-official-says.

[26] "Case Summary: $194 Million Settlement for Cleanup Work at the American Cyanamid Superfund Site in New Jersey," *Environmental Protection Agency,* 2015.

https://www.epa.gov/enforcement/case-summary-194-million-settlement-cleanup-work-american-cyanamid-superfund-site-new.

[27] "The Global E-Waste Monitor 2014," *United Nations University*, 2014. https://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf.

[28] "Waste Electrical and Electronic Equipment," *Eurostat*. http://ec.europa.eu/eurostat/web/waste/key-waste-streams/weee.

[29] Jessica Lyons Hardcastle, "Why Your Business Needs a Robust E-Waste Management System," *Environmental Leader*, July 1, 2016. http://www.environmentalleader.com/2016/07/01/why-your-business-needs-a-robust-e-waste-management-system/.

[30] Jessica Lyons Hardcastle, "E-Waste Export Bill Introduced in Congress," *Environmental Leader*, July 7, 2016. http://www.environmentalleader.com/2016/07/07/e-waste-export-bill-introduced-in-congress/.

[31] "Form 10-K for FY ending December 31, 2012", *Crown Holdings, Inc.* https://www.sec.gov/Archives/edgar/data/1219601/000121960113000007/cck-12312012x10xk.htm.

[32] Mark Rossi, "The Business Case for Knowing Chemicals in Products and Supply Chains," *United Nations Environment Program, 2014*. http://www.unep.org/chemicalsandwaste/Portals/9/CiP/Documents/CiPBusinessCase_Advance.pdf.

[33] Michael Blair, "Lumber Liquidators Still Looks Like a Good Short," *Seeking Alpha*, April 15, 2016. http://seekingalpha.com/article/3965461-lumber-liquidators-still-looks-like-good-short.

[34] Jennifer Rooney, "Brand Power to the People: J&J Takes Lead in Forbes Ranking," *Forbes*, October 5, 2011. http://www.forbes.com/sites/jenniferrooney/2011/10/05/brand-power-to-the-people-jj-takes-lead-in-forbes-ranking/#a72c7185aed9.

[35] Hubert Hsu, Carol Liao, "China's Baby Care Craze," *Forbes*, September 30, 2010. http://www.forbes.com/2010/09/30/china-baby-care-market-infant-milk-mothers-markets-economy-bcg.html; Andrew Moody, "Consumers Worried About Johnson & Johnson," *China Daily, April 27, 2011.* http://www.chinadaily.com.cn/bizchina/2009-04/27/content_7718793.htm; Mark Rossi, "The Business Case for Knowing Chemicals in Products and Supply Chains," *UNEP*.

[36] James Hamblin, "A Brewing Problem," *The Atlantic*, March 2, 2015. http://www.theatlantic.com/technology/archive/2015/03/the-abominable-k-cup-coffee-pod-environment-problem/386501/?utm_source=SFFB.

[37] Gregory Wallace, "Inventor of K-Cups Regrets the Idea," *CNN Money*, March 4, 2015. http://money.cnn.com/2015/03/04/news/k-cups-keurig-inventor-regrets/.

[38] Data from Bloomberg Terminal; Paul R. La Monica, "Decaf? Keurig Stock Down 70% This Year," *CNN Money*, November 17, 2015. http://money.cnn.com/2015/11/17/investing/keurig-green-mountain-k-cup-stock-kold/.

[39] "Is There a Serious Problem with Coffee Capsules?" *BBC News*, February 19, 2016. http://www.bbc.com/news/magazine-35605927.

[40] Elisabeth Comere, "Sustainable Packaging Trends for 2015: All About Millennials," *Triple* Pundit, January 7, 2015. http://www.triplepundit.com/2015/01/sustainable-packaging-trends-2015-millennials/#.

[41] Ian K. Clelland, Thomas J. Dean, Thomas J. Douglas, "Stepping Towards Sustainable Business: An Evaluation of Waste Minimization Practices in US Manufacturing," *University of Tennessee*, June 1, 2000. http://pubsonline.informs.org/doi/abs/10.1287/inte.30.3.107.11661.

[42] "Creative Inventory Solutions: Utilizing the Nonprofit Supply Chain," *Good360*, May 2013. http://69.59.162.218/nrf/scsummit2013/handouts/Creative_Inventory_Solutions_Doyle_Delph_Charles_Johnston_Pastor_Bright_Osigwe_Final.pdf.

[43] "The Business Case for Zero Waste," *General Motor.* https://www.gm.com/content/dam/gm/en_us/english/Group3/sustainability/sustainabilitypdf/GMs_Landfill-free_Blueprint.pdf; Joann Muller, "How GM Makes $1 Billion a Year by Recycling Waste," *Forbes*, February 21, 2013. http://www.forbes.com/sites/joannmuller/2013/02/21/how-gm-makes-1-billion-a-year-by-recycling-waste/.

[44] "P&G 2015 Sustainability Report," *P&G*. http://cdn.pg.com/-/media/PGCOMUS/Documents/PDF/Sustanability_PDF/sustainability_reports/PG2015SustainabilityReport.pdf?la=en-US&v=1-201605111505.

[45] Jessica Lyons Hardcastle, "Apple Strikes Gold With Recycling Efforts," *Environmental Leader*, April 19, 2016. http://www.environmentalleader.com/2016/04/19/apple-strikes-gold-with-recycling-efforts/.

[46] "Caterpillar: Design and business model considerations for heavy machinery remanufacturing," *Ellen MacArthur Foundation*. https://www.ellenmacarthurfoundation.org/case-studies/design-and-business-model-considerations-for-heavy-machinery-remanufacturing.

[47] "Caterpillar's Commitment to Sustainability: Doug Oberhelman's Remarks from the 2014 Shareholders Meeting," *Caterpillar*. http://www.caterpillar.com/en/news/caterpillarNews/sustainability/caterpillars-commitment-to-sustainability-doug-oberhelmans-remarks-from-the-2014-annual-shareholders-meeting.html.

[48] "The Benefits of Remanufacturing," *Caterpillar*. http://www.caterpillar.com/en/company/sustainability/remanufacturing/benefits.html.

[49] Jessica Lyons Hardcastle, "IBM Researchers Develop New Plastic Recycling Process," *Environmental Leader*, June 29, 2016. http://www.environmentalleader.com/2016/06/29/ibm-researchers-develop-new-plastics-recycling-process/#ixzz4EIh4lmjE.

[50] "Circular Economy," *Ellen MacArthur Foundation*. https://www.ellenmacarthurfoundation.org/circular-economy.

[51] "Towards the Circular Economy Vol. 1: an Economic and Business Rationale for an Accelerated Transition," *Ellen MacArthur Foundation*.

[52] Richard Dicks, "Discussing the Potential of the Circular Economy on Earth Day," *IBM*. https://www.ibm.com/blogs/think/2016/04/22/circular-economy-earth-day/.

[53] Victoria Knowles, "Interface has collected more nets than the weight of a humpback whale. Here's how it did it," 2degrees, October 31, 2014. https://www.2degreesnetwork.com/groups/2degrees-community/resources/interface-has-collected-more-nets-than-weight-humpback-whale-heres-how-it-did-it/.

[54] "Maersk Line: Using Product Passports to Improve the Recovery and Reuse of Shipping Steel," E*llen MacArthur Foundation*. https://www.ellenmacarthurfoundation.org/case-studies/using-product-passports-to-improve-the-recovery-and-reuse-of-shipping-steel.

[55] "Sustainable Apparel Materials," *MIT Materials Systems Laboratory*, October 7, 2015. http://msl.mit.edu/publications/SustainableApparelMaterials.pdf.

[56] Hayley Peterson, "Nike is Saving a Ton of Money on Its New Flyknit Shoes," *Business Insider*, September 5, 2014. http://www.businessinsider.com/nike-saves-money-on-flyknit-2014-9.

[57] "Sustainability," *Nike*. http://www.nike.com/us/en_us/c/sustainability.

[58] "Realizing Opportunities of a Circular Business Model," *DLL Group*. http://images.info.yoursolutionspartner.com/Web/servicedllgroupcom/%7Bee927947-b65e-4360-a153-79b0f9ed68d7%7D_Whitepaper_Realizing_opportunities_of_a_circular_business_model.pdf?elqaid=71&elqat=2&elqTrackId=2f5d60d79e744ee599ecea50b13497e9.

[59] "Using the Circular Economy to Improve the Lives of 3 Billion People," *DLL Group*. https://www.dllgroup.com/us/en-us/customer-stories/overview/philips.

[60] "Realizing Opportunities of a Circular Business Model," *DLL Group*.

[61] "Take-back" allows consumers to return end-of-life products to manufacturers and/or retailers. In some cases, manufacturers and/or retailers are obligated to offer take-back services.

[62] "Green Products: Using Sustainable Attributes to Drive Growth and Value," *PwC*. http://www.pwc.com/us/en/corporate-sustainability-climate-change/assets/green-products-paper.pdf.

[63] "The Business of Sustainability: McKinsey Global Survey Results," *McKinsey*, October 2011. http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/the-business-of-sustainability-mckinsey-global-survey-results.

[64] "Fifteen Percent of Employees Have Taken a Pay Cut to Work for Sustainable Companies," *Bain*, December 20, 2012. http://www.bain.com/about/press/press-releases/employee-sustainability-study-press-release.aspx.

[65] "Perspectives and Assumptions for Setting Resource Targets," *Sustainable Europe Research Institute*, January 2014. http://www.intress.info/fileadmin/intress-docs/Perspectives_and_assumptions_for_setting_resource_targets_01.pdf.

[66] Jamie Bohan, "This Recycling Company is Taking a Step Forward with Circular Economy," *USCCF*, March 29, 2016. https://www.uschamberfoundation.org/blog/post/recycling-company-taking-step-forward-circular-economy.

[67] "Recycling in America: In the Bin," *The Economist*. http://www.economist.com/blogs/democracyinamerica/2015/04/recycling-america.

[68] "The Swelling Middle," *Reuters*. http://www.reuters.com/middle-class-infographic.

[69] "Resources Futures," *Chatham House*, December 2012. http://www.resourcesfutures.org/downloads/CHJ204_Resources_Futures_WEB_28.01.13.pdf.

[70] "Waste To Energy (WTE) Market Analysis By Technology (Thermal, Biological) And Segment Forecasts To 2020," *Radiant Insights*, January 1, 2015. http://www.radiantinsights.com/research/waste-to-energy-wte-market-analysis-by-technology-thermal-biological-and-segment-forecasts-to-2020.

[71] Leon Walker, "Waste Management Energy Production Rivals Solar Industry," *Environmental Leader*, November 26, 2013. http://www.environmentalleader.com/2013/11/26/waste-management-energy-production-rivals-solar-industry.

[72] Jessica Lyons Hardcastle, "Trash Talk: Is Waste-to-Energy the Next Step in Sustainable Waste Management?" *Environmental Leader*, April 26, 2016. http://www.environmentalleader.com/2016/04/26/trash-talk-is-waste-to-energy-the-next-step-in-sustainable-waste-management/.

[73] Karen Hawks, "What is Reverse Logistics?", *Reverse Logistics Magazine*, Winter/Spring 2006. http://www.rlmagazine.com/edition01p12.php.

[74] "Project Results," *US Materials Marketplace*. http://materialsmarketplace.org/project-results/.

[75] "Corporate Citizenship 2015," *The Carlyle Group*. https://www.carlyle.com/sites/default/files/citizenship-report/tcg_ccr_2015.pdf; "Creating Sustainable Value" *KKR*. http://www.kkr.com/ar/downloads/KKR_ESG-Report_2012.pdf.

[76] "Putting a Price on Value," *PwC*. https://www.pwc.com/gx/en/sustainability/publications/assets/putting-a-price-on-value_pwc-private-equity-survey.pdf.

[77] Sustainability goes Mainstream: Insights Into Investor Views," *PwC*, May 2014. http://www.pwc.com/us/en/governance-insights-center/publications/assets/pwc-sustainability-goes-mainstream-investor-views.pdf.

[78] "Disclosure Effectiveness - Draft," *SEC Investor Advocacy Committee*, June 2016. https://www.sec.gov/spotlight/investor-advisory-committee-2012/iac-060716-draft-letter-to-commission-proposed-reg-sk.pdf.