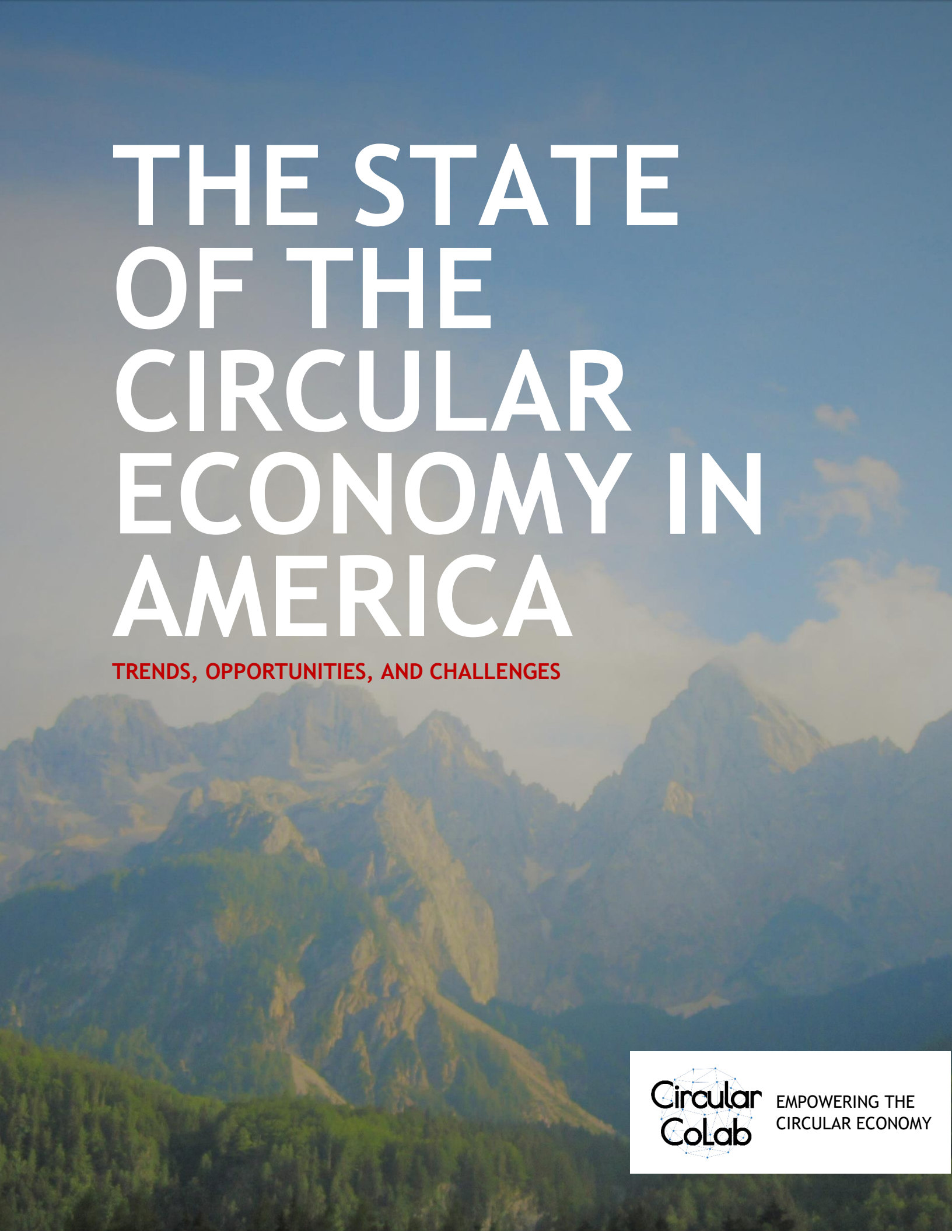


THE STATE OF THE CIRCULAR ECONOMY IN AMERICA

TRENDS, OPPORTUNITIES, AND CHALLENGES

Circular CoLab

EMPOWERING THE CIRCULAR ECONOMY

CONTENTS

INTRODUCTION

This report is about opportunities. Opportunities to create prosperity through positive environmental impact. Opportunities to develop businesses models that create job growth and investment. Opportunities to create an economy that allows us to REDEFINE our relationship to the planet.

GOALS OF THIS REPORT:

This report will support the development of the Circular Economy in America by:

1. ### Providing concrete examples of Circular Economy Solutions to spur education and awareness of the Circular Economy

   There can sometimes be a disconnect between the concept of the Circular Economy and what this means in practice. This report and the accompanying database provide real world examples of Circular Economy solutions and business models while illustrating the diverse and broad range of stakeholders and approaches that are currently being pursued in America. These examples can foster a deeper understanding of approaches that are needed to transition to a Circular Economy as well as create inspiration for the development of further solutions.

2. ### Highlighting Trends and Opportunities in the US Circular Economy space

   This report provides the first national scan of how Circular Economy solutions are being pursued in the United States. By categorizing each of the 202 initiatives according to their business model(s) and industry focus, the report will provide investors, policymakers, educators, corporations, and entrepreneurs with a better understanding of trends within the United States Circular Economy landscape as well as identify areas of future opportunities. Furthermore, the report offers case studies of innovative organizations as well as expert commentary and interviews on relevant topics.

3. ### Catalyzing Further Collaboration around Circular Economy solutions

   Transitioning to a Circular Economy will require the participation of everyone; entrepreneurs, policy makers, executive directors, educators, and consumers. In the absence of a national Circular Economy framework, this report hopes to facilitate more conversations and support for the development of Circular Economy solutions in America. Not only does adopting a Circular Economy provide environmental benefit, it also provides opportunities for new job growth and economic development. By utilizing the database, innovators can collaborate on solutions, mentor and support one another, and build networks to advocate for the development of a national Circular Economy in America.

WHO SHOULD READ THIS REPORT:

This report is intended for anyone who wants to understand what the Circular Economy means in practice and wishes to further the development of the Circular Economy in America and internationally.

METHODOLOGY

This report does not provide an exhaustive review of every Circular Economy related solution in the United States. (Although that would be wonderful!) Rather, it aims to provide a sampling of current Circular Economy projects and a high level scan of the variety of approaches and solutions being pursued in America. It is important to note that while the

term Circular Economy has only entered the mainstream in the last decade, many organizations and businesses including Caterpillar (since 1973 with their ReMan program) [i] and Goodwill (since 1902) have been successfully implementing Circular Economy principals for years without labeling them as such.

SELECTION CRITERA

To be included in the database, the initiative must focus on providing a solution that fits within the McKinsey ReSOLVE Framework of Regeneration, Sharing, Optimization, Looping, Virtualization, and Exchange that was developed for the Ellen MacArthur Foundation in 2015. The geographic scope of the report includes organizations that are headquartered or operational in America and/or working closely with American brands.

The ReSOLVE FRAMEWORK

REGENERATE Shift to renewable energy and materials; reclaim, retain, and regenerate the health of ecosystems; and return recovered biological resources to the biosphere.

SHARE Maximize utilization of products through peer-to-peer sharing of privately owned products or public sharing of pools of products; reuse them throughout their technical life spans; and prolong those life spans through maintenance, repair, and design for durability.

OPTIMIZE Improve the performance and efficiency of products; remove waste from their supply chains; and leverage big data, automation, and remote sensing.

LOOP Keep components and materials in closed loops and prioritize the inner ones. For finite materials, this means remanufacturing products or components and (as a last resort) recycling materials. For renewable materials, it involves anaerobic digestion and the extraction of biochemicals from organic waste.

VIRTUALIZE Deliver utility virtually—books or music, online shopping, fleets of autonomous vehicles, and virtual offices.

EXCHANGE Replace old materials with advanced renewable ones; apply new technologies, such as 3-D printing and electric engines.

Excerpted from *The Circular Economy: Moving from Theory to Practice*. Pg. 8 (2016) McKinsey & Company, https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/the-circular-economy-moving-from-theory-to-practice. Web. Accessed August 2018

After an analysis of initiatives in the database, each initiative was categorized according to the following Theories of Change and Industry Focus:

Theories of Change

Design: Focusing on the design phase of product, system, or material creation to enable better reuse, repair, recycling and/or incorporate less material usage. (All)

Education and Awareness: Building public, consumer, and/or government awareness and interest in Circular Economy principles and activities including recycling, research, repair, reuse, sharing, etc; (All)

Financing: Providing funds and investor support for the development of the Circular Economy Ecosystem. (All)

Information Transparency: Providing greater insight and transparency into current processes and/or systems. (Optimize)

Material Innovation: The development of new materials that are more sustainable from a production, lifecycle, and/or end of life standpoint than those currently in production. (Regeneration, Optimize, Loop, Exchange)

Product as a Service: Offering an alternative to ownership whereby the organization provides a service instead of selling a product. (Share, Optimization, Virtualize)

Product Life Extension: Creating methods to prolong the use and/or lifecycle of a given product through activities including repair, reuse, and remanufacturing. (Share)

Waste as a Resource: Utilizing what is considered waste and upcycling and/or recycling this material into another material or product. (Regeneration, Loop)

Industry Focus

Apparel: Includes organizations focused on textile production, clothing manufacturing, apparel retail outlets, secondary markets, and disposal.

Consumer Goods: Includes organizations that are focused on purchased items such as personal products, tableware/dinnerware, electronic goods, and household furniture. For the purposes of this report, apparel is not included in this category and is given its own label.

Food & Beverages: Includes organizations focused on the production, sales and disposal of food products including supermarkets, restaurants, and composters.

Healthcare: Includes organizations that deliver health related services including hospitals, pharmacies, and pharmaceutical companies.

Manufacturing: Includes organizations engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. The built environment is also included within the manufacturing sector.

Material Management: Includes organizations engaged in the waste management of post-consumer, post-commercial, post-industrial waste, and material recycling including materials such as plastics, steel, batteries. This category may sometimes overlap with Food and Beverage when considering organic waste.

Packaging: Includes organizations that design, produce, and dispose of packaging.

Supply Chain: Includes organizations involved in the movement of items such as information and materials through processes including the movement of supplier to manufacturer, or retailer to consumer.

Transportation: Includes organizations providing transportation services for passengers and/or goods.

Note that the above categories are used to classify solutions according to the industry they are focused on ***disrupting***. This is not necessarily the same as the industry category that the organization may be classified as.

I.e. Wasteless is a *technology* company that is disrupting the *Food and Beverage* industry.

SOURCES

The initiatives were selected from several sources including the Circular Economy Club Mapping Week results (accessed May 2018); Social Impact Accelerators and Impact Investing Networks; a public call for submissions, and a literature review of news and industry reports complied from January 2018 to August 2018. Every effort was made to ensure an un-biased approach to selecting initiatives. However, due to time limitations and/or lack of publically available information, the scope of this project did not focus on the renewable energy, environmental or agricultural regeneration, or extractive industries.

The organization description was either submitted directly by the organization or taken from the website and possibly edited for brevity.

ONLINE DATABASE

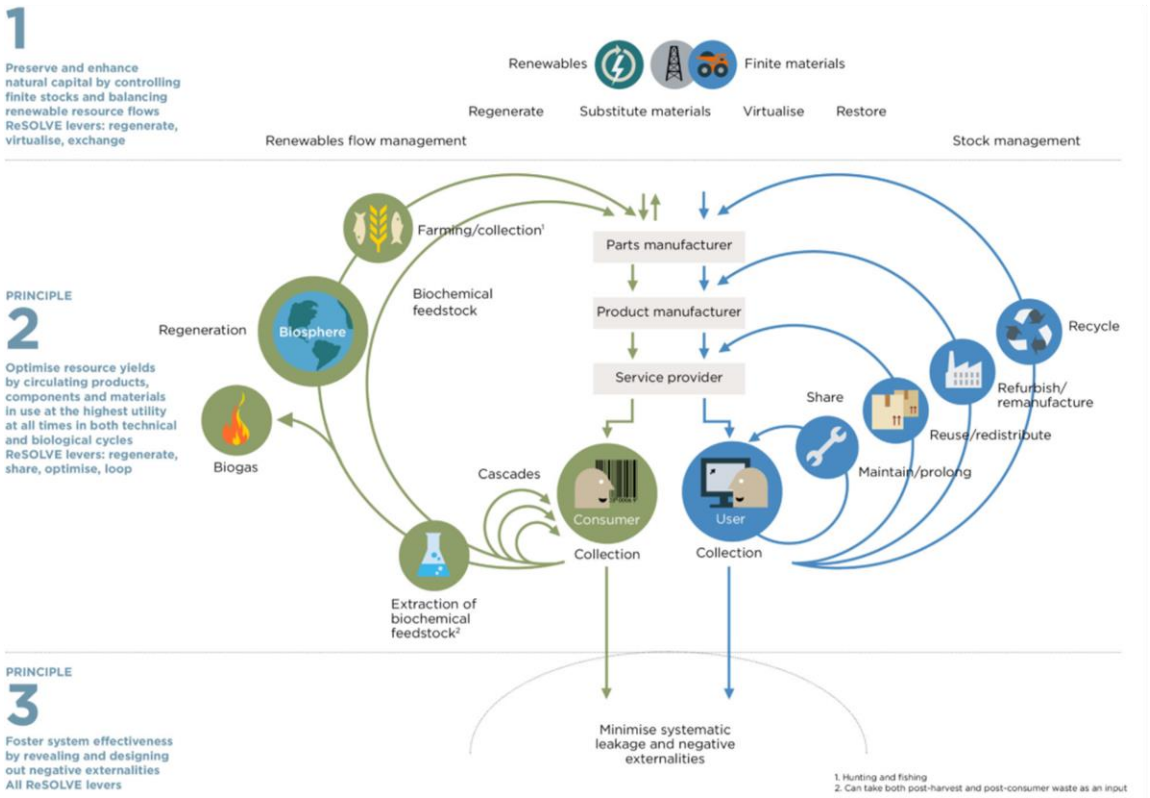
The final database of 202 initiatives that were analyzed for this report can be found online at www.circularcolab.org. We welcome further submissions and hope the database is utilized as an ongoing resource for those interested in furthering the development of a US Circular Economy. To be included, please submit your information on this link. https://www.circularcolab.org/usa-circular-economy-startup-survey/

For those who would like to join the movement to promote the development of the Circular Economy in America, please visit the www.circularcolab.org for further information.

ATTRIBUTION

WHAT IS THE CIRCULAR ECONOMY?

Our current economic growth is powered by a linear take, make, waste model that is unsustainable in a world of finite resources and ecosystem constraints. A circular economic model is the sustainable answer to decoupling continued economic growth from continued environmental degradation and pollution. This sustainable model would eliminate waste and increase productivity by focusing on the reuse and recycling of materials, the design of products to emphasize longevity and repair, and the creation of new business models including the sharing economy and the development of local closed loop systems.



Source: Circular Economy System Diagram, Ellen MacArthur Foundation, https://www.ellenmacarthurfoundation.org/circular-economy/interactive-diagram. Web. Accessed August 2018

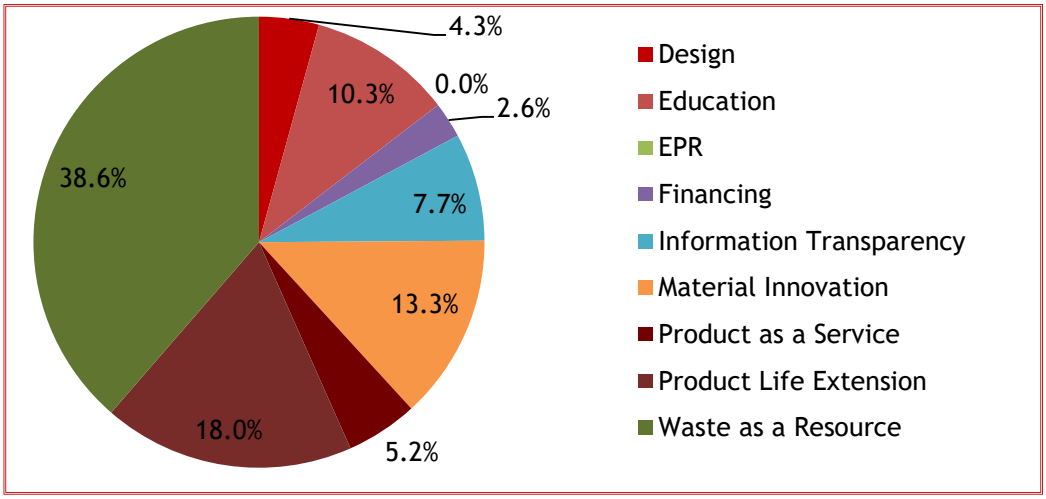
Benefits of adopting the circular economy model include new business opportunities through product creation and improved resource efficiency, decreased reliance on rare materials and other commodities, and the creation of high skilled job growth. A 2015 McKinsey and Ellen MacArthur Foundation joint study, Growth Within: A Circular Economy Vision for a Competitive Europe, estimates that for just for the EU alone, transitioning to a circular economy could add $1.8 trillion in value by 2030, decrease primary material consumption by 53% by 2050, and lower carbon dioxide emissions by 83% by 2050. The Circular Economy presents a truly win-win situation for the planet, people, and profit.

FINDINGS

As outlined in the Ellen MacArthur Circular Economy diagram above, transitioning to a Circular Economy necessitates the alignment of every process within the economic system. These processes include energy production, resource utilization, manufacturing and production, sales, collection, reuse, repair, and environmental regeneration. If just one of these steps is missing, for example, collection, than the entire system will cease to be circular because material outputs can no longer be returned into the system for further use.

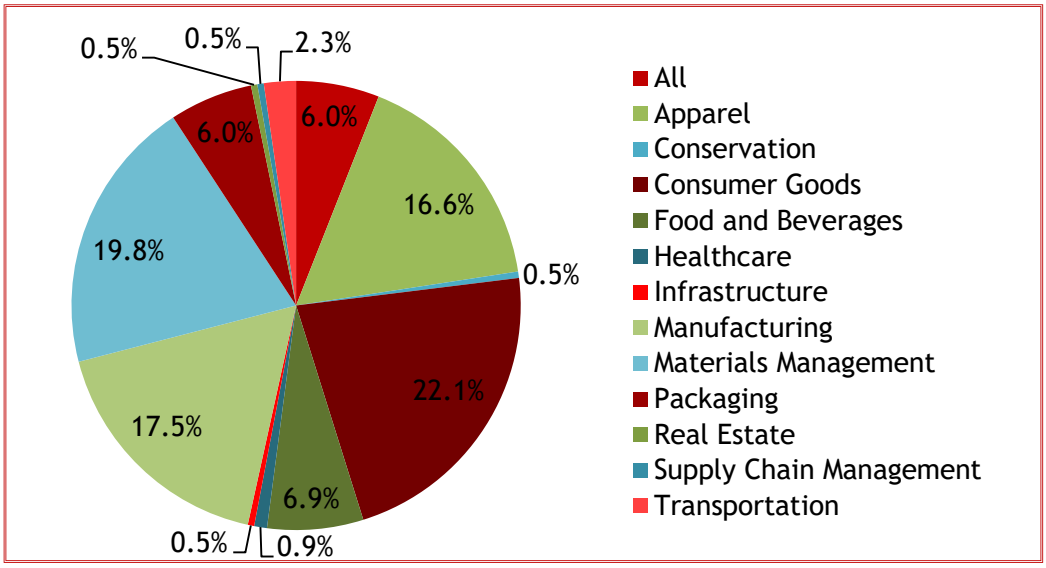
This section groups each initiative by its theory of change and industry focus. The aim is to provide insight into the types of business models and innovations that are being pursued, what industries are being disrupted, as well as opportunities to address gaps in innovation.

Chart 1. Circular Economy Initiatives: Breakdown by Theories of Change



N=233 (some organizations are focused on more than one Theory of Change)

Chart 2. Circular Economy Initiatives: Breakdown by Industry Focus



N=217 (some organizations are focused on more than one industry)

WASTE AS A RESOURCE

Utilizing what is currently considered waste and upcycling this material into another good or product

Waste as a Resource was the most common intervention point with 39% of initiatives incorporating this approach into their business model. This is an area that is expected to receive more attention given macroeconomic factors including China's recent ban on secondary material imports[ii].

Materials Management

Materials Management was the sector that most frequently incorporated Waste as a Resource into their business models making up 32% of Waste as a Resource initiatives. Organizations in this space include the development of innovations including advanced technologies to tackle plastics recycling (BioCellection, Purecycle), preventing textile waste from going to landfill (FabScrap, CarpetCycle), and online platforms to support businesses in the exchange of excess material or byproduct (US Materials Marketplace.)

Table 1. Waste as a Resource: Disrupting the Materials Management Industry

AMP Robotics	AMP Robotics has created Cortex, a robotic system that can rapidly pick recyclable materials off a conveyor belt for recovery. This is enabled by Neuron, artificial intelligence that peers into the recyclable stream to identify individual pieces of recoverable material.
Aqua Metals	Aqua Metals is reinventing lead recycling with its patented and patent-pending AquaRefining™ technology. These modular systems reduce environmental impact and scale lead acid recycling production capacity to meet growing demand.
BioCellection	BioCellection is a social impact for-profit startup, developing advanced technologies to transform unrecyclable plastics into virgin-quality chemicals for sustainable supply chains.
CarpetCycle	Our mission at CarpetCycle is a simple one: find uses for post-consumer carpet and divert a valuable non-degradable, non-renewable resource from landfills.
Demand Champion Program/Association of Plastic Recyclers	APR Recycling Demand Champions commit to purchase new volume Post-Consumer Resin through "work in process" (WIP) durable goods, or other applications for PCR.
Ecohub	Our sustainable product manufacturing process repurposes nearly 100% of the waste stream into value-added Black Carbon. By placing the focus on putting every piece of garbage to its highest and best use, Eco Hub delivers benefit to both the economy and the environment.
EcoStrate	EcoStrate transforms a variety of local and global post-consumer waste materials to create premium quality, longer-lasting, safer and cost effective composite products. Our traffic signage, indoor way-finder signage and flooring products are affordable, durable and sustainable
Envision Plastics	HDPE plastics recycling for food grade use. Envision Plastics was formed in 2001 after obtaining proprietary rights and patented

	technologies from Union Carbide.
FABSCRAP	Fabscrap is a nonprofit organization rethinking textile waste, providing pickup of unwanted fabric from NYC businesses and engaging the local creative community in reuse.
Full Cycle	Full Cycle tackles plastic pollution and climate change by transforming organic matter into a compostable alternative to oil-based plastics. It can replace a wide range of synthetic plastics, yet it is compostable and marine degradable once its useful life is over.
Grow NYC	GrowNYC is the sustainability resource for New Yorkers: We blanket the five boroughs with resources like textile and food scrap collection, Stop 'N' Swaps, and free training to make waste reduction easy for all.
Industrial Organic	I/O rapidly recovers water, energy and nutrients from food waste to produce high- value products such as organic fertilizers, animal feed and clean energy.
Loop Closing	Loop Closing recycles your organizations food scraps on-site using engineered composting systems and returns the finished compost to our soils.
Materials Marketplace	The Materials Marketplace is an award-winning regional and national platform to facilitate company-to-company industrial reuse. Ohio, Tennessee, and Austin are members.
Materials Recovery for the Future	Materials Recovery for the Future is an initiative of the Foundation for Chemistry Research and Initiatives, a 501(c)(3) tax-exempt organization established by the American Chemistry Council. Vision: Flexible packaging is recycled curbside and the recovery community captures value from it.
MAX AI (Bulk Handling Systems)	Max-AI® technology is an artificial intelligence system that identifies recyclables and other items for recovery.
Michigan Re:source	Re:Source is a state initiative that promotes the use of recycled materials in economic and business opportunities in Michigan. Michigan Economic Development Corporation (MEDC) and the Department of Environmental Quality (DEQ) are working together.
One NYC	The City is committed to becoming a worldwide leader in solid waste management by achieving the goal of Zero Waste by 2030, eliminating the need to send waste to out-of-state landfills and minimizing the overall environmental impact of the city’s trash
Paper Tube & Core Corp.	Paper Tube & Core works with the end user of rolled products (paper, plastics, textiles) to recycle tube/core scrap from their production. Cores are processed and returned to the market for re-use. PTC recycles for re-use over 14,000,000 pounds of cores per year for re-use.
Precious Plastic LA	We are the Los Angeles branch of the world wide open source DIY project started by inventor Dave Hakkens to put the power of recycling plastic in the hands of individuals and communities. We bring together people in Los Angeles interested in solving the plastic

	pollution problem.
Purecycle	Our ground-breaking, patented recycling process, developed by Procter & Gamble, separates color, odor and any other contaminants from plastic waste feedstock to transform it into virgin-like resin.
Replynsh	Replenysh is creating the building blocks of the circular economy — helping brands close the loop on their products and provide an amazing experience for consumers.
rPlanet Earth	Recycling company that sorts baled PET bottles from California materials recovery facilities and converts them into food grade packaging, bottle preforms and sheet under one roof.
Smarter Sorting	Using machine learning to ID different substances and sort faster, burn less. We create closed-loop data systems that help retailers and municipalities handle tricky regulated products (paint, aerosols, cleaners, etc.)
SWEEP	The Municipal Market SWEEP Standard evaluates the environmental, economic and social aspects of delivering municipal solid waste activities. The standard will be achievable by municipal governments of all sizes and covers a range of activities.
TerraCycle	TerraCycle is an innovative recycling company that has become a global leader in recycling hard-to-recycle waste. TerraCycle offers a range of free programs that are funded by conscientious companies, as well as recycling solutions available for purchase for almost every form of waste.
The Remade Institute	The mission of the REMADE Institute is to enable the early stage applied research and development of key industrial platform technologies that could dramatically reduce the embodied energy and carbon emissions associated with industrial-scale materials production and processing.
Threadcycle	Threadcycle collects and recycles textile waste (only focusing on that which is smaller than 1/2 yard square because that cannot be made into new garments) into new raw materials. We break down the materials using heat to create carbon.
Zeus Industrial Products	Zeus Industrial Products announced it has developed a chemical recycling process to depolymerize PLA so the monomers can be reused in new plastic. Its process can be used to separate PLA from PET in mixed-polyester streams.

EDITORIAL

UNDERSTANDING CHINA'S IMPACT ON THE DOMESTIC RECYCLING MARKET

By Cole Rosengren, Senior Editor of Waste Dive

In recent years, the U.S. has traditionally exported about 30% of its recyclable material. China was the prime importer for much of it - as well as for materials from many other countries - until 2018.

In July 2017, China informed the World Trade Organization that it would be banning 24 types of scrap material and setting an allowable contamination rate for everything else at near zero. The full ban took effect in January 2018. New contamination standards were enforced starting in March. In May, China banned additional material categories and announced a freeze on import licenses that continued into June. In late summer, the country enacted a 25% tariff - in response to one from the U.S. - on just about everything else that was still getting imported.

Throughout this transition, some hoped that Southeast Asian countries could fill the gap. While that has been proven true to some extent, and those countries continue to import material, many have taken their own steps to limit or ban the growing amount of displaced scrap. Vietnam, Thailand, Indonesia, Malaysia and Taiwan are the prime examples. India still remains a large buyer of fiber products, and exports are still going elsewhere, but more and more the attention is turning inward for ways to handle this in the U.S.

While the U.S. already uses a large amount of its recyclable material domestically, the country will need more infrastructure to fill the demands of this inelastic supply chain. That may mean new facilities that both process and use material for manufacturing here, or facilities that can at least create marketable plastic pellets and paper pulp for use by overseas manufacturers. Signs of investment for both approaches - including from Chinese companies - have already begun popping up around the country.

In the meantime, recycling companies are raising the cost of doing business and passing this back to their customers. A small but growing number of local governments have been limiting or canceling their recycling programs as a result of this cost squeeze. Some state governments are engaged, but this has opened up an array of new questions about who is responsible to ensure recycling remains viable amid a decentralized policy structure in the U.S. New corporate funding from big name brands is beginning to flow into local programs via nonprofits or investment funds, though some question whether this is enough.

Many expect it to get worse before it gets better, but that better future is expected to be more circular. Cities are looking for ways to keep their materials local and derive the intended benefits. Companies want a reliable place to send the material they're being paid to get off the curb every day. Packaging manufacturers are increasingly interested in finding ways to source more post-recycled content to meet ambitious sustainability goals.

Those in the thick of it are looking for ways to frame this as an opportunity, rather than a crisis, and follow China's lead by closing the loop for a more circular domestic economy. Though as long as landfill space remains plentiful in multiple regions of the U.S. (at least for the next couple decades depending on the calculation) it may be hard to force the current economic system to change enough to make this possible.

Low tip fees are the baseline comparison - whether that be curbside recycling, organics processing or anything else - and they are tough to compete with. Certain non-profit recyclers have been talking about the need for a different type of "full cost accounting" system that would also factor in emissions, potential post-closure surprises and other expenses that landfills can incur. This has begun to catch the attention of some government officials, but will be a hard-fought change if it ever comes to pass.

Yet even the CEOs of some of the country's largest waste and recycling companies recognize that landfills aren't a forever solution. As soon as an economic case can be made for recycling (or perhaps even reuse) the winds will shift. One of the key questions to watch in the years to come is what or who will help create enough momentum to move us past that tipping point.

Despite all the attention being given to China's recycling disruptions, ocean plastic pollution and related topics, it still feels like a stretch to think that the average American will be willing to come to terms with their consumption enough to actually force the issue. Until then, it's more likely that we'll keep looking for new places to send all of this stuff rather than questioning whether we actually need all of it in the first place.

Manufacturing

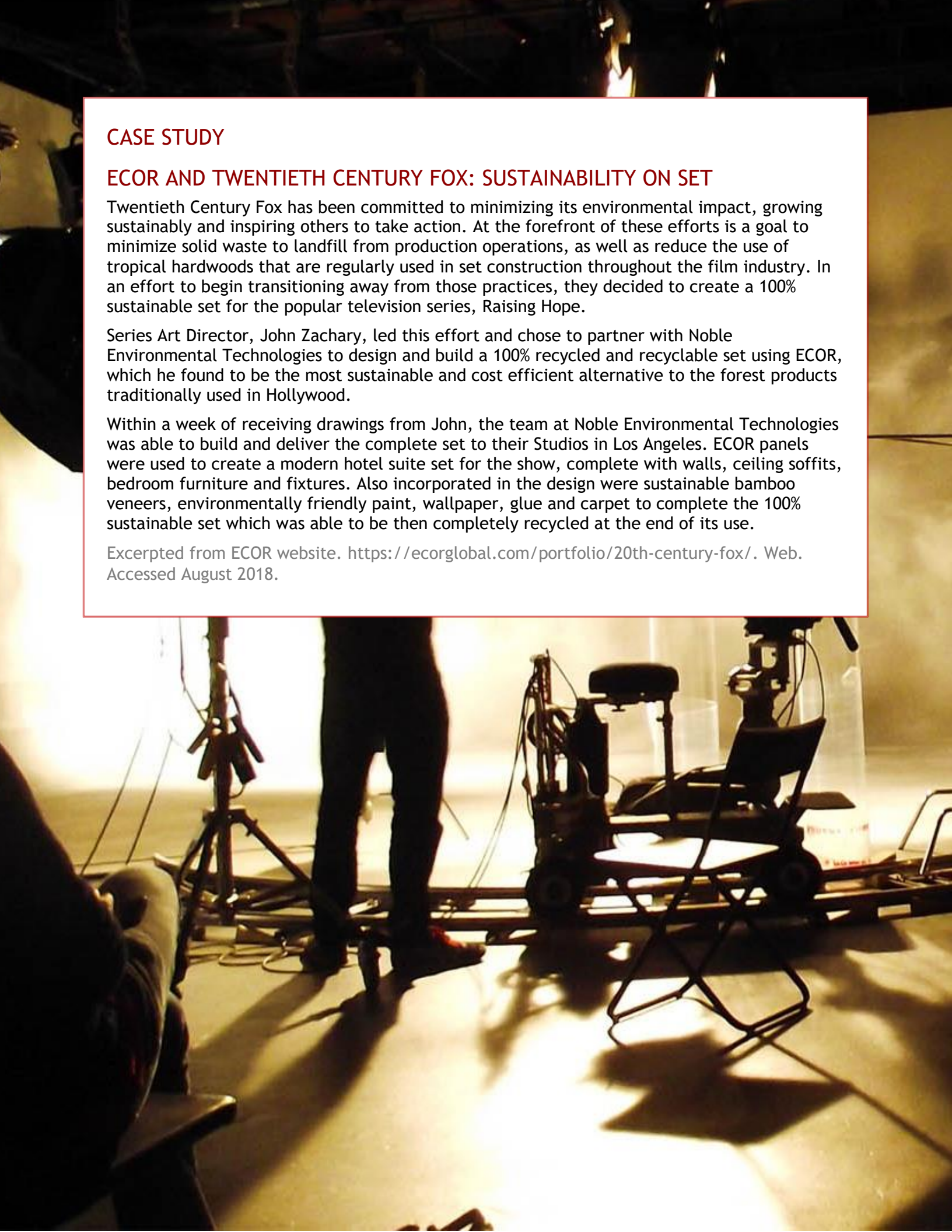
Manufacturing made up 26% of initiatives that incorporated Waste as a Resource as part of their business model. Many of these organizations were focused on the built environment with waste materials being incorporated into products including walls, composite decking, interior surfaces, and tile (Building Product Ecosystems, ECOR, Ecostrate, Grenite, Icestone, Interface, Kohler, Trex.) Other solutions focused on the utilization of CO2 (Calera, Carbon Engineering) and the closed loop recycling of tires (Leigh Technologies.)

Table 2. Waste as a Resource: Disrupting Manufacturing

Building Product Ecosystems	Focused on closed loop building materials, specifically Closed Loop Wallboard or Glass in Concrete, in partnership with Google, Durst, and Facebook.
Calera	Calera's Calcium Carbonate, made from CO2, can be used in a variety of applications. The material is produced as a fine free-flowing white powder. It can function as a supplementary cementitous material (SCM)
Carbon Engineering	Carbon Engineering is building technologies to capture CO_2 directly from the atmosphere, and to use that CO2 in the synthesis of clean transportation fuels that displace crude oil.
Connora Technologies	Connora has developed a low energy, solution based recycling process specific to our epoxy resins. High value materials like carbon fiber can be recovered in near virgin and woven form. End-of-life products can now be recycled, while maintaining standard performance characteristics.
Cruz Foam	Cruz Foam transforms chitin, a biopolymer found in shrimp shells, into structural foams with an environmentally friendly process. Cruz Foam addresses both the front-end and back-end of a 'green' product by up-cycling chitin found in waste to create foam to replace petroleum-based foams.
Demand Champion Program/Association of Plastic Recyclers	APR Recycling Demand Champions commit to purchase new volume PCR through "work in process" (WIP) durable goods.
Earthship Biotecture	Earthship is a type of house built with natural and recycled materials with energy conservation in mind. Designed to produce electricity, water, and food-self-sufficient.
ECOR	ECOR was developed using principles of waste stream reduction and diversion with the goal of solving one of the world's most challenging environmental problems - waste disposal and diversion. ECOR is made from waste fiber, water, and heat.
EcoStrate	EcoStrate transforms a variety of local and global post-consumer waste materials to create premium quality, longer-lasting, safer and cost effective composite products. Our traffic signage, indoor way-finder signage and flooring products are affordable, durable and sustainable
Full Cycle	Full Cycle tackles plastic pollution and climate change by transforming organic matter into a compostable alternative to oil-

	based plastics. It can replace a wide range of synthetic plastics, yet it is compostable and marine degradable once its useful life is over.
Grenite	Recycled surfaces for countertops, kitchen & bath, back splashes, wall cladding, flooring and more. For retail, hospitality, convenience stores, residences, workshops and everywhere else where stone or engineered surfaces are used.
IceStone	Ice Stone began in 2003 with a simple concept; transform waste glass into something beautiful.
Interface	ReEntry Used Carpet Collection Program that is reprocessed into new product. Net Works Collection program whereby Fishing Net is used to produce new product. Climate Take Back program and Carbon Neutral products.
IntergriCo	IntegriCo's patented technology mixes recycled landfill-bound plastic to create composite railroad ties that far exceed industry standards for high consistency and structural integrity. Our raw material cost is lower than others in our industry.
Johnson Controls Recycling	Johnson Controls is the world's largest manufacturer and recycler of conventional vehicle batteries. Nearly every vehicle battery uses materials that can be continually recycled, which makes vehicle batteries both economical and sustainable.
Kohler	We're taking industrial waste and creating high-end tiles for Ann Sacks, with some made from 100% waste materials. Using a collection of secondhand tools and equipment, we design and create tile forms and craft dry-pressed tiles with exquisite glazes.
Lehigh Technologies (acquired by Michelin Tires)	The company's process works with scraps that already have been stripped of metals and fibers, using liquid nitrogen to turn the remaining rubber cold enough so that it can be pulverized into a fine composite. Lehigh sources that material from tire recyclers or as part of closed-loop arrangements with tire manufacturers.
Midland Compounding & Consulting, Inc.	Midland Compounding is producing new plastic compounds made from nylon recycled from carpet and carbon fiber recovered from Aerospace manufacturing. These compounds are being used as new raw materials for automotive manufacturing.
Nuvosil	The solar industry consumes almost half of the silicon raw materials used in the production of solar cells. Nuvosil is focused on innovating the remanufacturing of the silicon waste to valuable end-market industrial applications.
The Remade Institute	The mission of the REMADE Institute is to enable the early stage applied research and development of key industrial platform technologies that could dramatically reduce the embodied energy and carbon emissions associated with industrial-scale materials production and processing.
ReUse Wood	The American Wood Council (AWC) and Canadian Wood Council (CWC) have partnered with Building Materials Reuse Association (BMRA) to develop an online North American directory outlining reuse

	and recycling options for wood and wood products.
Rewall	We proudly make our building products from 100% recycled beverage cartons, cups and their components. ReWall's zero waste zero water process takes a composite material - cartons, and upcycles them into very durable, moisture and mold resistant composite panels.
TREX	When you donate your unwanted plastic materials to Trex, not only are you helping to keep thousands of pounds of waste out of landfills, you're also helping us to continue to create beautiful and environmentally responsible outdoor products.



CASE STUDY

ECOR AND TWENTIETH CENTURY FOX: SUSTAINABILITY ON SET

Twentieth Century Fox has been committed to minimizing its environmental impact, growing sustainably and inspiring others to take action. At the forefront of these efforts is a goal to minimize solid waste to landfill from production operations, as well as reduce the use of tropical hardwoods that are regularly used in set construction throughout the film industry. In an effort to begin transitioning away from those practices, they decided to create a 100% sustainable set for the popular television series, Raising Hope.

Series Art Director, John Zachary, led this effort and chose to partner with Noble Environmental Technologies to design and build a 100% recycled and recyclable set using ECOR, which he found to be the most sustainable and cost efficient alternative to the forest products traditionally used in Hollywood.

Within a week of receiving drawings from John, the team at Noble Environmental Technologies was able to build and deliver the complete set to their Studios in Los Angeles. ECOR panels were used to create a modern hotel suite set for the show, complete with walls, ceiling soffits, bedroom furniture and fixtures. Also incorporated in the design were sustainable bamboo veneers, environmentally friendly paint, wallpaper, glue and carpet to complete the 100% sustainable set which was able to be then completely recycled at the end of its use.

Excerpted from ECOR website. https://ecorglobal.com/portfolio/20th-century-fox/. Web. Accessed August 2018.

Apparel and Consumer Goods

Initiatives focused on the apparel and consumer goods sector also incorporated Waste as a Resource frequently into their business models, with these two sectors making up 32% of Waste as a Resource initiatives. Solutions trended towards ones focused on the creation of new products utilizing post-consumer materidals (8hz, GreenToys, Indosole) while some organizations even engaged in the creation of economic development opportunities by employing the local workforce in the collection of feedstock (Bureo, Thread.)

Table 3. Waste as a Resource: Disrupting the Apparel and Consumer Goods Industry

8hz	8hz transitions single use plastic waste into consumer products. Our fabric is made from 100% recycled plastic bottles and manufactured in Ventura California
Alchemy Goods	Alchemy Goods designs and manufactures stylish bags and accessories from up-cycled materials including bicycle inner tubes and advertising banners in Seattle, WA, USA.
Bureo Skateboards	At Bureo, we make skateboards from recycled fishing nets. Our recycling program in Chile, 'Net Positiva', provides fishing net collection points to keep plastic fishing nets out of our oceans.
Cotton 2040 Partnership	Cotton 2040 is a unique cross-industry partnership focused on the recapture and reuse of cotton fibers in textiles has the potential to transform the cotton industry and yield significant sustainability benefits for the sector
Eileen Fisher Renew	At Eileen Fisher, we design clothes to last. But nothing, not even your favorite sweater, lasts forever. That's why we've created Renew, a take-back and reuse program that preserves the value of our clothes at every stage, in any condition. It's part of our commitment to being circular by design.
Everybody.world	EVERYBODY.WORLD makes and sells thoughtful goods. Inspired by reality, people, cultures, science, history, and life. We approach design and manufacturing as a new frontier–conscious of Workers, Ecology and Ideas.
Evernu	Evrnu has invented a truly regenerative fiber made from post-consumer cotton textile waste. In partnership with manufacturers and brands the technology converts solid waste into a liquid, then transforms it into a new pure fiber that can take on the characteristics the designer needs.
Green Toys	At its core, Green Toys Inc. has always been an eco-friendly toy company. From our 100% recycled materials to our US-based manufacturing, we're raising awareness about sustainability while delivering unquestionably safe products.
I:Collect (I:CO)	I:CO®, short for I:Collect, is a global solutions provider for apparel, footwear and other textiles collection, certified sorting, reuse and recycling. I:CO aims to keep consumers' used clothing and shoes in a continuous closed loop production cycle where these goods can be reprocessed and reused again and again.

Indosole	We repurpose tires into the soles of some of the most durable footwear around.
Interface	ReEntry Used Carpet Collection Program that is reprocessed into new product, also Net Works Collection program whereby Fishing Net is used to produce new product. Climate Take Back program and Carbon Neutral products.
Levi's Waterless and Wasteless Programs	Designers set out to create an entirely new approach for using less water in the finishing process. The result? Our Levi's® Water<Less™ collection. Waste<Less Collection- products are made of 20 percent post-consumer waste- specifically, recycled plastic bottles. That works out to an average of three to eight plastic bottles per jean
LooptWorks	A Portland, Oregon based business that up-cycles or re-purposes abandoned, pre-consumer and post-consumer materials into limited edition products.
Mango Materials	Mango Materials produces a naturally occurring biopolymer from waste biogas (methane) that is economically competitive with conventional oil-based materials.
Materia Madura	Material Madura is a furniture and vessel collection made from an innovative material derived from plantain and coffee waste. This project offers an alternative to agricultural waste and recycling with a non-toxic, sustainable, locally sourced, and biodegradable material.
Materials for the Arts	Materials for the Arts is New York's premiere reuse center, providing a way for companies and individuals to donate unneeded supplies to thousands of nonprofit organizations with arts programming and public schools.
Moo Cotton Business Cards	The world loves T-shirts. But the process of making them creates a lot of leftover fabric. So we decided to put those scraps to good use and make Cotton. Our first tree-free paper.
One Thousand	One in One Out program. All gear wears out eventually, so just as we try to eliminate waste upfront, One In / One Out is our effort to close the loop and prevent our apparel from becoming landfill waste at the end of its life.
Patagonia Recycled Polyester, Yulex Rubber, Worn Wear	By recycling old products, we can keep many of the same materials in circulation for years. In 2005 we began taking back worn out Patagonia clothing for recycling. Today, you can return any Patagonia product to us and we will reuse it, recycle it into new fabric or make it into a new product.
Rare Form	We repurpose vinyl billboards into one-of-a-kind bags. Billboards are made out of durable vinyl and are typically 12' x 48' ft.
Repreve	We transform recycled bottles into an amazing fiber, used by the world's leading brands to make athletic and fashion apparel and more. Our process embeds properties like wicking, adaptive warming and cooling, water repellency, and more at the fiber level. For reliable, durable quality.

Rothy's	Our mission was to create the most stylish, comfortable shoe for today's on-the-go woman. And do it with low-waste, low-impact materials, hand-assembled for high quality and durability. Hence Rothy's was born.
SugaMat	Suga manufactures premium quality yoga mats in the USA from 100% recycled wetsuits. Offering a return service and life-time replacement warranty for their mats.
Thread International	We take trash from some of the poorest neighborhoods on the planet and we transform it into fabric. Then we sell that fabric along with a 100% transparent supply chain to anyone who wants to make more responsible dresses, tops, shoes, and bags.
Tyton Technology	Tyton technology is a leader in the field of apparel recycling, and we can manufacture product to replace virgin materials without added cost or compromises in quality.
UpCycleItNow	We are a design and manufacturing company that turns materials that would have been destined for the landfill into beautiful and functional products.
UrbanBarrels	At Urban Barrels we take old and unused sailboat sails and repurpose them into stuff. With our recycling initiative, we save these beautiful fabrics from collecting dust in attics, or worse, ending up in our landfills.
Verterra	Made of 100% renewable resources and BPI-certified compostable, VerTerra's Dinnerware From Fallen Leaves™ are the stylishly sustainable alternative to disposable paper and plastic plates. No trees are ever harvested or cut down for this line.
Wearable Collections	What if we could bring the convenience that New Yorkers demand to clothing recycling? By placing bins within apartment buildings, residents can now recycle clothing as easy as they can recycle cans and newspapers.
Zero Waste Daniel	The first line of zero waste clothing, made from reroll, the fabric of the future. Zed is composed of 100% scrap material. We are the first company making 100% zero waste clothes.

CASE STUDY

THREAD INTERNATIONAL - TACKLING POLLUTION AND POVERTY

Thread International is a for-profit social enterprise that was founded in 2010 to tackle poverty and pollution in Haiti. The organization employs locals in Haiti, Honduras, and Taiwan to collect and sort PET bottles. The PET bottles are then transformed into finished consumer products in its Pittsburgh facility.

Thread builds responsible, transparent supply chains from Ground to Good™. We invest heavily in the first mile of our supply chains - the individuals and areas where plastic bottles are picked up from the ground. The first mile of supply chains is an area often ignored and as a result, this portion of supply chains tend to cause ecological and human harm.

A recently released McKinsey report showed that supply chains are responsible for more than 90% of the environmental impact of products, leaving less than 10% of direct environmental impact in the hands of consumers.

Thread has also found that enormous opportunity for social impact exists in the first mile of supply chains. Often, the work at this stage is informal, unregulated, and difficult to monitor. The individuals involved are constantly evolving, making it difficult to track exactly who is responsible for the collection of raw materials. While there is a movement among apparel brands to become increasingly transparent and publicly list their suppliers, many brands are only able to list their tier 1 and maybe tier 2 suppliers. The places where goods are cut and sewn, or perhaps where the fabric is finished. Textile supply chains are long and complicated. Before a fabric is finished, it must go through several processing steps and vendors who extrude, spin, knit and weave fibers together before it is dyed and finished.

At Thread, we are proud to not only publicly list every vendor we work with to create our fabric, but the individuals who pick up the bottles that make our fabric as well. Until this level of transparency is commonplace, and this understanding of the first mile of supply chains is ubiquitous across industries, social and environmental harm will continue. We cannot fix what we don't know. It is time for us to know

Excerpted from Thread Inc's 2016 Impact Report, https://xsk3xwkdu22koij1jdxh7e43-wpengine.netdna-ssl.com/wp-ontent/uploads/2017/11/Thread_ImpactReport_2016.pdf . Web. Accessed August 2018

Food and Beverage

Food and Beverage made up 9% of the total number of Waste as Resource initiatives in the database. About half of these initiatives are non-profits with a focus on providing food to low income communities (CityHarvest, Commonwealth Kitchen.) Other organizations concentrated on the transformation of food byproduct or surplus into new edible goods (Regrained, Misfit Juicery) or into compost (LA Compost.) For those interested in learning more about the myriad of organizations addressing food waste in America, please view the ReFED Innovator Database at https://www.refed.com/tools/innovator-database.

Table 4. Waste as a Resource: Disrupting the Food and Beverages Industry

City Harvest	City Harvest, 5013 nonprofit, operates in New York City through food rescue and distribution, and education. Since 1982, City Harvest has rescued more than 500 million pounds of food.
CommonWealth Kitchen	CommonWealth Kitchen (“CWK”) promotes equity, economic opportunity, and community resilience by leveraging the universal power of food to drive inclusive entrepreneurship, create sustainable employment, improve healthy food access, and build the infrastructure needed for a just, sustainable food economy.
Compost Now	We collect food scraps from residents and businesses to help them reduce waste and support local gardens.
GoodR	At GOODR, we believe that hunger is not a scarcity or lack of resource issue, it’s a logistics problem. We are the only food management company that collaborates with organizations in compliance with the Internal Revenue Service thru our blockchain enabled platform to increase corporation’s bottom line through their charitable donations.
Gristmill	Zero-waste restaurant. We are committed to adhering to sustainable practices in our restaurant, too. Nothing goes to waste in the kitchen – every leaf, stem, skin and shell is used to provide you with profound pleasure.
LA Compost	Our mission at LA Compost is to connect the people of LA to the soil, and each other. In pursuit of our mission we are building local infrastructure and educational programs to support the just transition of food waste into a resource for healthy soils.
Mistfit Juicery	Our juices are made with “ugly” produce that usually fills landfills because they don’t fit our grocery beauty ideals.
ReGrained	ReGrained rescues the nutritious grain created every time that beer is brewed. Brewing beer processes the sugar out of the grain. This gives us optimal access to protein, fiber, and a whole bunch of micronutrients. We upcycle this grain into SuperGrain+ flour using our patent-pending tech.

Other

The remaining initiatives incorporating Waste as a Resource into their theory of change were focused primarily on packaging (Method, Ecologic Brands) along with solutions aimed at conservation (Rainforest Connection) and public infrastructure (Cheese Brine.)

Table 5. Waste as a Resource: Other

Rainforest Connection	Old cell phones are placed in rainforests and combined with AI to detect illegal practices such as lobbing, narco trafficking, or wildlife poaching.
Cheese brine to salt roads	Using the salt brine of cheese manufacturers of the county to salt roads in winter.
Method Ocean Plastic	We packaged this 2-in-1 formula in bottles made with a blend of recovered ocean plastic and post-consumer recycled plastic, a combination that results in a uniquely gray resin. Innovation is a beautiful thing
E6PR	The E6PR™ is the first ecofriendly six pack ring made from by-product waste and other compostable materials, designed to replace the plastic rings, which are truly damaging to our environment.
Ecologic Brands	Ecologic Brands, Inc. is an Oakland, California-based company that designs and manufactures bottles from recycled cardboard and newspaper.

PRODUCT LIFE EXTENSION

Creating methods to prolong the duration or use of a given product through activities including donation, repair, reuse, remanufacturing and the replacement of single use items with reusable products.

Business models in this category have created a unique niche whereby they specialize in the reutilization of goods. This is the second most popular business model with 18% of initiatives incorporating this approach. This is not a new industry as the reselling of secondhand goods has been in place since the Salvation Army was formed in the late 19th century. In addition, online secondhand markets have been available since 1995 with the founding of CraigsList and EBay.

More recently the growing popularity of e-commerce has enabled specialization in a greater variety of products as well as broader consumer reach. In addition, there is a growing repair movement as well as an already established remanufacturing industry in America that are both dedicated to prolonging product life.

The secondary market sector that has developed for the sale of previously owned products is one that is expected to grow. One in three women shopped in secondhand outlets in 2017 and the resale market is expected to hit $41 billion by 2022.[iii] Just this year, the Real Real, a luxury consignment center raised $100 million in its Series G[iv] and Backmarket, a Paris based technology repair and remanufacturing marketplace, raised $47 million its Series A.[v]

Consumer Goods

The most common sector focus for Product Life Extension was for Consumer Goods, comprising 55% of Product Life Extension initiatives. Besides the resale of secondhand goods as mentioned above, Product Life Extension can also be achieved through the replacement of singe use products such as razor blades (Albatross Razors) and packaging (Fillgood) with multi-use alternatives.

Table 5. Product Life Extension: Disrupting the Consumer Goods Industry

Albatross Razors	Stainless steel razors with replacements blades that last for a lifetime. Take-back program as well. "By eliminating plastic from the shaving equation we hope to prevent the creation of unnecessary plastic waste and the pollution associated with it."
America's Remanufacturing Company	We are a reverse logistics & remanufacturing company who reduces costs, protects brands, and keeps our earth clean. We help manufacturers, distributors, & retailers manage their returned products through our 4R Process: Recovery, Remanufacturing, Resale, & Recycling.
Amoeba Music	Bring us your CDs, LPs, DVDs, 45s, books, 78s, 12”s or video games! At Amoeba Music, you can trade in your old stuff and get cash or 30% more in a credit slip that you can use to shop with whenever you want.
AptDeco	We're dedicated to creating a simple and enjoyable process for buying & selling quality pre-owned furniture. AptDeco offers a complete end-to-end process to bring back the joy of discovering amazing furniture finds for your home.
Burton Snowboards	We're shifting our soft goods to lifetime warranty and doubling our repair amount.

Custom Fits Best	I am a visual artist specializing in handwork, design, and design development processes. My goals are to share skills, and enlighten minds via creative encounters with technology, paired with taking care of the things we make.
Davies Office	As a nationally recognized leader in green remanufacturing and sustainable office solutions, Davies provides innovative offerings designed to make the most of your existing assets and future investments.
Dell Reconnect	Dell has made it easy for you to recycle or refurbish your used computer equipment through Dell Reconnect, a partnership with Goodwill Industries.
Eva Cup	A reusable menstrual cup to replace tampons and pads. It's made of the highest quality FDA approved medical grade silicone with SGS / Intertek / ISO Certification."
Fillgood	Fillgood's mission is to reduce disposable plastics. We provide eco-friendly home and body products: reusable items or products delivered in a compostable or refillable packaging. We also offer a local refill service: products are home delivered in glass containers that we take back when empty.
Fitness Equipment Depot Global	Rebirth Fitness specializes in providing remanufactured equipment. This allows gym and health club owners to still provide their customers with quality equipment they can trust, and also save them up to 70% off buying new.
Fixup	Fixup's goal is to re-invent repair for a sustainable, circular economy. We repair household items of all kinds: lamps, chairs, appliances, jewelry, toys, you name it. We work creatively with local partners, to create convenient drop off locations where customers can leave their broken stuff for repair.
GoldSeal Refurbished Systems for GE	By purchasing a GoldSeal refurbished system you will receive an exceptional value. Refurbished in facilities using a quality system that is ISO 13485 certified, GoldSeal like-new preowned systems can increase your clinical capability without draining your budget.
Goodwill Donate Program	Goodwill has made recycling a quick and easy process. We are open for donations with day, evening and weekend hours to make it convenient.
iFixIt	iFixit is a wiki-based site that teaches people how to fix almost anything. Anyone can create a repair manual for a device, and anyone can also edit the existing set of manuals to improve them. Our site empowers individuals to share their technical knowledge with the rest of the world.
Kay Chesterfield	We create pillows, cushions and reupholster furniture for the commercial industry.
Life Without Plastic	The one-stop shop for safe, high quality, ethically-sourced, Earth-friendly alternatives to plastic products for everyday life

Package Free Shop	A zero waste shop in NYC, offers everything that individuals need to transition to a low waste lifestyle in one place.
The Real Real	Online site for online luxury consignment
Rebrickable	Rebrickable will show you which LEGO sets you can build from the sets and parts you already own. You can choose from official LEGO sets or thousands of MOCs (My Own Creations) submitted by hundreds of designers. All MOCs include building instructions and full parts lists.
Repair Association	The Repair Association is a place where repair industry professionals can meet on common terms to discuss issues that relate to us all, network with other members, and move our businesses and our industry forward. The Association represents DIY hobbyists and independent repair technicians, to environmental organizations and the aftermarket.
The Remanufacturing Institute	The Remanufacturing Industries Council (RIC) is a strategic alliance of businesses and academic institutions that works across industry sectors to support the entire remanufacturing industry through a combination of collaboration, education, advocacy, and research.
University Student Used Good Swaps	Many universities have developed programs to deal with the amount of material that students leave behind after the move out. Harvard, BU, Tufts, and Emory all have programs which range from donation to Goodwill, sales for charitable funds, free student exchanges, and community markets.

Apparel

The apparel industry is also a focus of Product Life Extension business models. 26% of organizations incorporating Product Life Extension concentrated on providing solutions to the textile and apparel space. Besides the traditional method of donating or exchanging secondhand apparel, product life extension in this sector can also take the form of repair or a new business model, recommerce. With recommerce, businesses ask existing customers for their used items and repair the secondhand clothing to as- good-as-new condition and sell them for a discount off the original retail price (Eileen Fisher, North Face, Patagonia.) While material production costs are removed, collection, reverse logistics, and repair costs are important elements in determining if recommerce can develop into a sustainable business model. Education and consumer awareness of this new product category will also be needed to drive greater demand.

Table 6. Product Life Extension: Disrupting the Apparel Industry

Buffalo Exchange	Buy, sell, or trade your clothes and accessories at Buffalo Exchange for cash or trade on the spot. You can shop for men's and women's clothing.
Eileen Fisher Renew	At Eileen Fisher, we design clothes to last. But nothing, not even your favorite sweater, lasts forever. That's why we've created Renew, a take-back and reuse program that preserves the value of our clothes at every stage, in any condition.
Goodwill Donate Program	Goodwill has made recycling a quick and easy process. We are open for donations with day, evening and weekend hours to make it

	convenient.
I:Collect (I:CO)	I:CO®, short for I:Collect, is a global solutions provider for apparel, footwear and other textiles collection, certified sorting, reuse and recycling.I:CO aims to keep consumers' used clothing and shoes in a continuous closed loop production cycle where these goods can be reprocessed and reused again and again.
Indigo Proof Denim Repair	Indigo Proof specializes in high quality denim restoration and repair, done on antique Singer 47w70 darning machines. I also provide denim tailoring and modifications. Repair, don't replace!
North Face Renewal	The North Face Renewed is a collection of refurbished clothing remade to explore. It's the great quality and performance you expect from The North Face with less impact on the earth.
Patagonia Recycled Polyester, Yulex Rubber, Worn Wear	By recycling old products, we can keep many of the same materials in circulation for years. In 2005 we began taking back worn out Patagonia clothing for recycling. Today, you can return any Patagonia product to us and we will reuse it, recycle it into new fabric or make it into a new product.
The Real Real	Online site for online luxury consignment
Renewal Workshop	The Renewal System takes discarded apparel and textiles and turns them into Renewed Apparel, upcycled materials or recycling feedstock. Data is collected on everything that flows through the system and is given back to our brand partners to help them improve the production and design of future products.
ThredUp	We're the world's largest online secondhand shopping destination with thousands of like-new styles from your favorite brands at up to 90% off retail. We make sure every single one of the 15K new arrivals we add to the site every day is 100% authentic and in good shape.
Yerdle	Yerdle's mission is to reduce the amount of stuff people buy new by 25%. We execute this mission by helping brands create and operate resale programs for their products. Our highly customized logistics and technology solutions extend the lifecycle of products by getting them out of people's closets and putting them back into use.

Packaging

Packaging was another sector being disrupted by the product life extension model with 14% of initiatives addressing the packaging space. Most of the initiatives were focused on transitioning from single-use material or product, to multi-use options. As consumers become increasingly aware of the environmental issues caused by the longevity of many plastic based single use items, we expect to see an increasing trend in the use of reusable and/or compostable material.

Table 7. Product Life Extension: Disrupting the Packaging Industry

Ancolie	Ancolie offers delicious and healthy meals served in eco-friendly glass jars.
Boomerang Water Systems	No larger than a hotel icemaker, our mini water-bottling machine connects to a facility's municipal water source; filtering out all impurities and then sanitizing, filling, and capping glass and aluminum bottles of water on-site.
Go Box	Get your take-out meal in a reusable, returnable GO Box container from over 80 vendors (and growing) in downtown Portland.
Just Salad	Take-out lunch and catering company that has reusable/returnable bowls and uses local fresh products.
LimeLoop	LimeLoop is a full circle shipper and data solution for B2C. The sustainable route for sending and receiving goods. What if shipping boxes could be used 50 times? 100 times?
Ronnybrook	Milk jug take back program

UNDERSTANDING EXTENDED PRODUCER RESPONSIBILITY

In recent years, the concept of extended producer responsibility (EPR) has caught on, first in Europe in the 1990s and since then in the rest of the world, including the U.S. The concept is relatively simple: Companies that make consumer goods are given responsibility for managing their products and packaging at their end of life. The concept, as the Journal of Cleaner Production points out, is to turn what was formerly waste "into the 'food' for industry and the next generation of products."

According to Reid J. Lifset, associate director of the industrial environmental management program at Yale and editor of the Journal of Industrial Ecology, an EPR bill was introduced by Senator Max Baucus (D-MT), then chairman of the Senate Environment and Public Works Environmental Protection Subcommittee, in 1992, but it faced stiff industry opposition and was never enacted. There is still no national EPR law, and no immediate prospects for one.

While EPR laws on packaging in the U.S. have yet to take hold at the state level, there are already 115 state and municipal EPR laws in 13 different product categories, including pharmaceuticals (27 laws), electronics (24 laws), thermostats (13 laws), batteries (11 laws), paint (nine laws), and mattresses (three laws), according to Scott Cassel, CEO of the Product Stewardship Institute (PSI). EPR and similar product stewardship laws exist in other categories, including auto switches, carpet, cell phones, fluorescent lighting, pesticide containers, and solar panels. The leading states, with up to eight laws, are California, Vermont, and Maine. Connecticut, another leader, has EPR programs for electronics, paint, mattresses, and mercury thermostats, and is studying packaging. The state's 2016 Comprehensive Materials Management Strategy states that "EPR does not simply shift costs from the public sector to the private sector; it seems to minimize costs through economies of scale, product design and other market forces."

Excerpted from "The Producer Pays." Knowledge@Wharton website, 4 June 2017
http://knowledge.wharton.upenn.edu/article/the-producer-pays/. Web. Accessed August 2018

Manufacturing

For the manufacturing sector, which made up 12% of the Product Life Extension category, solutions were mostly concentrated on the built environment.

Table 8. Product Life Extension: Disrupting the Manufacturing Industry

Big Reuse	By salvaging usable items from demolition and remodel projects and reintroducing them to the market, we take a small step toward eliminating these significant environmental costs.
Caterpillar ReMan	Cat Reman recovers materials through differentiated technology and employs environmentally sustainable practices to restore components to good-as-new condition.
Home Depot	The official B2B auction marketplace for Home Depot Liquidation, featuring customer returns and overstock. Register to bid on pallets and truckloads of material
The Remanufacturing Institute	The Remanufacturing Industries Council (RIC) is a strategic alliance of businesses and academic institutions that works across industry sectors to support the entire remanufacturing industry through a combination of collaboration, education, advocacy, and research.
Rochester Institute of Technology	The Center for Remanufacturing and Resource Recovery (C3R®) at Rochester Institute of Technology is internationally recognized as the leading center for research and development in the remanufacturing field.

MATERIAL INNOVATION

The development of materials that have less environmental impact in their production, use, and/or end of life.

13% of initiatives incorporated Material Innovation into their business model. Solutions in this category included the development of entirely new material categories such as bio-degradable plastics, the creation of less resource intensive processes in the creation of materials, and the replacement of material with a more environmentally friendly alternative. Material Innovation can be closely tied to Waste as a Resource whereby organizations incorporate waste material into their end product and/or material.

Manufacturing

39% of Material Innovation initiatives focused on disrupting the Manufacturing industry. Within manufacturing, solutions were concentrated primarily on finding plastics replacements as well as providing alternative materials for the Built Environment. Innovations include the utilization of GHG's in material creation (Natureworks, NewLight Technologies, US Concrete), creating composite panels from cartons (Rewall), and using a material found in shrimp shells to create a replacement for foam (Cruz Foam.)

Table 9. Material Innovation: Disrupting the Manufacturing Industry

Cradle 2 Cradle Innovation Institute	The Cradle to Cradle Products Innovation Institute, a non-profit organization, administers the Cradle to Cradle Certified™ Product Standard.
Cruz Foam	Cruz Foam transforms chitin, a biopolymer found in shrimp shells, into structural foams with an environmentally friendly process. Cruz Foam addresses both the front-end and back-end of a 'green' product by up-cycling chitin found in waste to create foam to replace petroleum-based foams
Ecovative	A world leading biomaterials company creating and scaling environmentally- friendly products that are cost and performance competitive with conventional materials. At Ecovative, we use mycelium to grow materials.
Full Cycle	Full Cycle tackles plastic pollution and climate change by transforming organic matter into a compostable alternative to oil-based plastics. It can replace a wide range of synthetic plastics, yet it is compostable and marine degradable once its useful life is over.
Grenite	Recycled surfaces for countertops, kitchen & bath, back splashes, wall cladding, flooring and more. For retail, hospitality, convenience stores, residences, workshops and everywhere else where stone or engineered surfaces are used.
Ingeo-Natureworks	Nature looks at greenhouse gases, like atmospheric carbon, as a feedstock, a raw material. NatureWorks, we're doing the same thing – using our best technologies to turn greenhouse gases into a portfolio of polylactic acid (PLA) performance materials called Ingeo.
The Remade Institute	The mission of the REMADE Institute is to enable the early stage applied research and development of key industrial platform technologies that could dramatically reduce the embodied energy and carbon emissions associated with industrial-scale materials

	production and processing.
NewLight Technologies	AirCarbon™ is a material made by sequestering carbon emissions that would otherwise become part of the air. AirCarbon is made by combining air with methane-based carbon emissions to produce a material that is approximately 40% oxygen from air and 60% carbon and hydrogen from captured methane emissions by weight.
Nuvosil	The solar industry consumes almost half of the silicon raw materials used in the production of solar cells. Nuvosil is focused on innovating the remanufacturing of the silicon waste to valuable end-market industrial applications.
Rewall	ReWall's zero waste zero water process with a miniature carbon footprint differs vastly from manufacturing of the traditional materials we replace. We take a composite material - cartons, and upcycle them into very durable, moisture and mold resistant composite panels.
US Concrete	The company uses EF Technology® for concrete which is a process that uses alternative cementitious materials that results in the reduction of greenhouse gases.
US Green Building Council	The U.S. Green Building Council is committed to a sustainable, prosperous future through LEED, the leading program for green buildings and communities worldwide.

Apparel

29% of Material Innovation initiatives were focused on the Apparel sector. Many of these initiatives also included Waste as a Resource business models. Examples included incorporating methane gas to create fiber (Mango Material), utilizing scrap to create fabric rolls (ZWD), developing textiles made from post-consumer cotton (EVERNU) and developing more sustainable processes in the creation of denim (Levi's Waterless Jeans.)

Table 9. Material Innovation: Disrupting the Apparel Industry

Cotton 2040 Partnership	Cotton 2040 is a unique cross-industry partnership focused recapture and reuse of cotton fibers in textiles has the potential to transform the cotton industry and yield significant sustainability benefits for the sector.
Evernu	Evrnu has invented a truly regenerative fiber made from post-consumer cotton textile waste. In partnership with manufacturers and brands the technology converts solid waste into a liquid, then transforms it into a new pure fiber that can take on the characteristics the designer needs.
Everybody.world	EVERYBODY.WORLD makes and sells thoughtful goods. Inspired by reality, people, cultures, science, history, and life. We approach design and manufacturing as a new frontier–conscious of Workers, Ecology and Ideas.
Levi's Waterless and Wasteless Programs	Designers set out to create an entirely new approach for using less water in the finishing process. The result? Our Levi's® Water<Less™ collection. Waste<Less Collection- products are made of 20 percent post-consumer waste- specifically, recycled plastic bottles. That works out to an average of three to eight plastic bottles per jean
Mango Materials	Mango Materials produces a naturally occurring biopolymer from waste biogas (methane) that is economically competitive with conventional oil-based materials.
Patagonia Recycled Polyester, Yulex Rubber, Worn Wear	The Yulex® natural rubber in our wetsuits comes from sources that are Forest Stewardship Council® certified by the Rainforest Alliance. Up to ~80% less climate-altering CO2 was emitted in the manufacturing process when compared to traditional neoprene.
Science of Apparel	We spent a full year engineering fibers with style and sustainability in mind. We believe in comfort, convenience, and conservation, and we welcome you to join our initiative.
Tyton Technology	Tyton technology is a leader in the field of apparel recycling, and we can manufacture product to replace virgin materials without added cost or compromises in quality. The tunability and flexibility of the platform make it uniquely suitable for the varied needs of the fashion industry, where circular market solutions are in high demand.
Zero Waste Daniel	The first line of zero waste clothing, made from reroll, the fabric of the future. ZED is composed of 100% scrap material. We are the first company making 100% zero waste clothes. We make unique yet affordable fashion pieces by applying the art of sewing to the scraps that abound due to fashion industry's wasteful practices.

INTERVIEW

INCLUSIVITY AND CIRCULARITY IN APPAREL: EVERYBODY.WORLD

Iris Alonzo, Co-Founder of Everybody.world, talks about the vision and mission of Everybody.world.

Tell us why Everybody.world was created?

My business partner, Carolina Crespo and I had a collective 26 years of experience in apparel. Before a single EVERYBODY.WORLD piece was born, we decided that what we stood for was making thoughtful goods without exploiting people or the planet. In reinventing what a fashion company can be, EVERYBODY.WORLD is bringing depth and humanity to apparel.

An integral part of this was utilizing waste material and celebrating workers. What was the ethos behind this and how did you get from idea to reality?

Sustainability and worker-ethics play a strong role in the company's identity. The ethos of EVERYBODY.WORLD can really be boiled down to respect for Workers, Ecology, Ideas. That means championing worker's rights, respecting the planet, and collaborating with creative minds to make enjoyable clothing.

With regards to utilizing waste material: Pushing boundaries through textile sustainability and by eliminating waste from the manufacturing cycle are at the core of our ethical and ecological approach. We invented a proprietary yarn from 100% recycled cotton—the first of its kind in the world. We're continuing to develop new materials and intend to build the best basics line in the world—from trash.

Can you tell us more about Everybody.World's calls for collaboration with creators and material innovators? Why are you talking this approach? Any successes and/or failures?

Our Contributor Collection is designed by everyday extraordinary people. The one rule is that they can't be actual designers! Right now, our collaborators range from a 76-year-old man who plays chess in the park to a landscape architect, a musician, a retired nurse, and a very opinionated four-year-old. Their individual spirit, style and ideas are what unite them. We commit to each of their items for a year and they receive 10% of the sales of their designs.

What would be your ideal vision for the apparel industry in 10 years? What is needed to get there?

We believe that the future of fashion is circular. Certainly the apparel industry's old business model is out of style, and hopefully with a merger of technology and creativity we can push the evolution forward in the areas of recycled textiles and ethical manufacturing.

Food and Beverage and Packaging

Material Innovation solutions in Food and Beverage are closely tied to the creation of biodegradable and/or compostable materials as well edible materials for serving ware. Food and Beverage along with Packaging made up 19% of Material Innovation initiatives.

Table 10. Material Innovation: Food and Beverage, and Packaging

Amborella Organics	Our intention at Amborella Organics is for customers to eat an organic lollipop and plant their biodegradable stick, made from recycled paper in soil to simultaneously decompose and grow. The heirloom seed inside the lollipop stick correspond to the herb or flower inside our purpose driven candy.
E6PR	The E6PR™ is the first ecofriendly six pack ring made from by-product waste and other compostable materials, designed to replace the plastic rings, which are truly damaging to our environment.
Elk Designs	Elk is leading the way to bring exceptional sustainable packaging solutions to the packaged goods industry.
Loliware	LOLIWARE is the first and only edible disposable cup that provides a completely new drinking and eating experience. 100% plastic-free, gluten-free, gelatin-free, BPA-free, non-GMO, all natural, non-toxic, safe, and FDA approved.
VeriFood LLC	VeriFood LLC is a company working group dedicated to a more robust environmental vision for food & packaging. VeriFood distributes products contain renewable raw materials of agricultural origin such as non-genetically modified starch derived from crops.
Verterra	Made of 100% renewable resources and BPI-certified compostable, VerTerra's Dinnerware From Fallen Leaves™ are the stylishly sustainable alternative to disposable paper and plastic plates.

Consumer Goods

13% of Material Innovation initiatives addressed the Consumer Goods sector. The solutions included finding creative methods to utilizing waste such as transforming scrap textiles into business cards (Moo Cards) and providing solutions to enable better end-of-life recycling (Burton.)

Table 11. Material Innovation: Disrupting Consumer Goods

Brush with Bamboo	The world's most eco-friendly toothbrush. Every component is plant-based: bristles, handle, wrapper, and box.
Burton Snowboards	We now have a small portion of our board line using a product called ReRez. Resin is the glue that holds a snowboard together. With ReRez, if you put the scrap or the actual snowboard into a safe acidic solution at the end of its life, you can separate out all of the materials and then turn them into other uses and even upcycle them.
Materia Madura	Materia Madura is a furniture and vessel collection made from an innovative material derived from plantain and coffee waste. This project offers an alternative to agricultural waste and recycling with a non-toxic, sustainable, locally sourced, and biodegradable material.
Moo Cotton Business Cards	The world loves T-shirts. But the process of making them creates a lot of leftover fabric. So we decided to put those scraps to good use and make Cotton. Our first tree-free paper.

EDUCATION, AWARENESS AND ADVOCACY

Organizations focused on creating more education, awareness and advocacy for the development of Circular Economy solutions made up 10% of all initiatives analyzed. These organizations can be broken into two groups. Higher Education Institutes such as Universities which provide teaching, research, and collaboration opportunities and non-profits or industry groups concentrating on one specific industry, behavior, or geographic location.

It is important to note that the organizations included below represent just a small sampling of the variety of Circular Economy related industry groups in America. For example, within the Materials Management industry which includes waste management and recycling, there are dozens of organizations. However, there is currently only one organization, the Circular Economy Industries Association, which is focused on addressing Circular Economy policy at the national legislative level.

Universities

Table 12. Education: Universities

Arizona State University	Arizona State University, approaches Circular Economy through a three-pronged strategy. In Education, ASU provides executive and graduate education certification through a program on Ethical Circular Economy Implementation. In Practice, ASU collaborates with local partners in the greater Phoenix area. Additionally, ASU has developed the Resource Innovation and Solutions Network, a global collaborative of public and private partners.
Georgia Tech	1. The Ray C. Anderson Center for Sustainable Business focuses on the circular economy as a key theme for research on business innovation. 2. Staff at the Brooks Byers Institute for Sustainable Systems seek to understand how information, energy and materials are utilized within large complex systems and to discover new novel approaches for increasing economic resiliency. 3. The Center for Biologically Inspired Design aims to take advantage and knowledge from strategies by which biological systems provide principles that can be used to solve complex challenges in the design and manufacturing of human systems from products to city infrastructure.
UC Davis	The Industrial Ecology Network is a program geared towards providing skills, training and applications in industrial ecology, focusing on the system perspective, materials, manufacturing and the circular economy.
Rochester Institute of Technology	The Center for Remanufacturing and Resource Recovery (C3R®) at Rochester Institute of Technology is internationally recognized as the leading center for research and development in the remanufacturing field.
Worcester Polytechnic Institute	1. WPI's research connects with circular economy in a number of areas including biotechnology, fuel cells, nanotechnology and sustainable materials processing. 2. The concept of a regenerative circular economy is embedded across key elements of the curriculum in a number of undergraduate and graduate course at WPI.

NON-PROFITS & INDUSTRY ASSOCIATIONS

Table 13. Education: Other

Beyond the Label	BtL is a charitable organization that addresses the question “What's in my tee?” to encourage shoppers to consider what their T-shirt is made of and how their purchase affects the world, workers and themselves.
Biomimicry Institute	Our goal today is for biomimicry to become a natural part of the design process. We accomplish this by tackling one massive sustainability problem at a time through our Design Challenges platform, mobilizing tens of thousands of practitioners with the support of the Global Biomimicry Network to solve the challenge, and then providing those practitioners with AskNature as a tool to begin the solution process.
Building Materials Reuse Association	The Building Materials Reuse Association (BMRA) is a 501 c3 non-profit educational and research organization whose mission is to advance the recovery, reuse and recycling of building materials.
California Product Stewardship Council	The California Product Stewardship Council (CPSC) is a powerful network of local governments, non-government organizations, businesses, and individuals supporting policies and projects where producers share in the responsibility for managing problem products at end of life.
Circular Economy Industries Association	The Circular Economy Industries Association (CEIA) is a trade association made up of companies and organizations that wish to define the policy-focused priorities and objectives that will best enhance their circular economy activities in North America. CEIA is focused on implementing a government-engagement effort designed to increase the business value of circular economy products, services, and business models.
Circular Seattle	We're a group of designers, companies and govt officials looking to create a circular economy in Seattle. Our focus is Food & Textiles to match IDEO's focus.
French Plastic	French Plastic promotes organizations and initiatives that forge a cleaner future through new ideas on plastic. The name “French Plastic” derives from France’s landmark ban on single-use plastic cutlery.
Global Green	Global Green USA works in partnership with public agencies, communities, design innovators, and other nonprofits to create innovative and replicable policies, programs and procedures that make sustainability the standard during the planning, design, construction and operation of a built environment.
Grow NYC	GrowNYC is the sustainability resource for New Yorkers: We blanket the five boroughs with resources like textile and food scrap collection, Stop 'N' Swaps, and free training to make waste reduction easy for all.
Kiehl's Recycle & Be	One Empty Container = One Stamp* ... Only full-size product will receive a stamp, deluxe samples and complimentary products can be

Rewarded	returned for recycling but do not warrant a stamp. Each customer can redeem one reward per month
Open Source Circular Economy (OSCEdays)	The Open Source Circular Economy Days (OSCEdays) is an open group of people that started in 2015 with a global event promoting Open Source as the key driver for a Circular Economy. Since then, people in over 100 cities across the globe got active and discussed and developed Open Source Circular Economy through practical hands on activities.
Precious Plastic LA	We are the Los Angeles branch of the world wide open source DIY project started by inventor Dave Hakkens to put the power of recycling plastic in the hands of individuals and communities. We bring together people in Los Angeles interested in solving the plastic pollution problem.
Product Stewardship Institute	The Product Stewardship Institute (PSI) is a national, membership-based nonprofit committed to reducing the health, safety, and environmental impacts of consumer products across their lifecycle with a strong focus on sustainable end-of-life management. We take a unique product stewardship approach to solving waste management problems by encouraging product design changes and mediating multi-stakeholder dialogues.
The Recycling Partnership	We bridge the gaps between the communities and the industries that benefit from recycling by creating campaigns that power local recycling programs. We help solve and energize curbside recycling problems.
ReFED	ReFED is a multi-stakeholder nonprofit, powered by an influential network of the nation’s leading business, nonprofit, foundation, and government leaders committed to reducing U.S. food waste.
The Remade Institute	The mission of the REMADE Institute is to enable the early stage applied research and development of key industrial platform technologies that could dramatically reduce the embodied energy and carbon emissions associated with industrial-scale materials production and processing.
ReThread DC	ReThread decreases the environmental harm of textiles by educating DC residents on what to do with unwanted clothing and textiles, promote the benefits of reuse and recovery, share local resources for reuse and recovery and to create more local opportunities to reuse and recover unwanted textiles.
UpStream	Upstream works to replace today's throw-away society with a culture of stewardship.
Zero Waste San Diego	Zero Waste San Diego’s mission is to create, promote and implement programs that maximize management and conservation of resources, reduce greenhouse gas emissions that contribute to global warming, and persuade citizens, businesses, and governments in the San Diego County region to adopt a zero waste philosophy.

INTERVIEW

THE GLOBAL PERSPECTIVE, SITRA

Kari Herlevi, the Project Manager of Circular Economy for SITRA, the Finnish Innovation Fund, shares his thoughts on global developments in the Circular Economy space.

Q: What do you think has been the most exciting development recently within the Circular Economy space?

K: One of the greatest things that happened is the China ban on foreign secondary material. I recently traveled to Australia and you can see how suddenly, this ban has forced them to think about their waste and to determine local solutions to managing their waste. Now they are building a national roadmap and policy framework around better materials management. Globally, you can see that this type of conversation is happening as a direct result of China. It's very exciting.

Q: So you see recycling and waste management as a big part of developing a Circular Economy?

K: Not just recycling, but certainly materials management as a whole. Just this summer we published a report with the European Climate Foundation, Reconfigure: The Circular Economy. The analysis looks at Steel, Aluminum, Cement, and Plastics and proposes actions that could lead to an emissions reduction of 56% in the EU and a reduction in global emissions of 3.6 billion tons per year. This reduction would account for half of the amount we would need to have emissions stay at net zero! Many of these actions are dependent on better re-circulation and processing of the materials we've already been producing.

Q: Can you share more about how Finland and Europe as a whole views the Circular Economy? Why there has been such strong support for Circular Economy policies here?

K: For us in Finland, we view the development of the Circular Economy from a business and economic development lens. It's about job creation, developing businesses that are competitive in a resource constrained world, and really positioning ourselves to be the global leaders in the funding and developing of future solutions. Of course culturally, the people of Finland and across much of Europe do possess very strong environmental concerns. But in general, the Circular Economy here is about opportunities for business to innovate and differentiating our industries so we are competitive in a global economy. This makes me think that California, with its entrepreneurial and environmental culture, would be a great place to start exploring Circular Economy models. If you could showcase new business models and economic opportunities here, it could really inspire the rest of the country.

INFORMATION TRANSPARENCY

Providing greater insight and transparency into current processes and/or systems

8% of initiatives in the database incorporated Information Transparency as part of their business model. This is an area that has seen rapid growth due to the arrival of cloud based services and IoT supported by technologies including sensors, GPS and RFID. Almost all organizations developing Circular Economy solutions within this space are start-ups with the majority operating in the materials management sector.

Materials Management

Materials Management was the most popular sector being targeted for transformation by Information Transparency initiatives with 50% of information transparency solutions oriented towards this sector.

The materials management space is ripe for disruption because the waste sector has been notoriously opaque as well as slow to adopt new technology. Better information transparency in this sector is very important as this is the first step in creating a baseline for improvement. Awareness and knowledge of material flows can result in higher diversion rates upstream as well as better strategies for managing revenues and costs in the collection and processing of secondary materials.

Services have been developed for cities, haulers, commercial and multifamily units, and corporations. Solutions include providing logistics management for haulers, (RecycleTrack, Recyclops), monitoring of waste levels, types of waste produced, and amount recycled (Trashtalk, Zerocycle) and even the geographic tracking and verification of waste shipments (BAN.)

Table 13. Information Transparency: Bringing Materials Management into the Future

Basel Action Network	BAN's mission is to champion global environmental health and justice by ending toxic trade, catalyzing a toxics-free future, and campaigning for everyone's right to a clean environment. BAN's namesake is the 1989 United Nations Basel Convention, which restricts the trade of hazardous waste between more developed countries and less developed countries.
Enevo	Enevo is a provider of waste and recycling services. By collecting waste data using wireless sensors, Enevo can measure and forecast fill-levels in waste containers in order find where waste management operations can be further streamlined and costs reduced
Hygiea	With Hygiea, you can monitor the level of trash in any given can and know how frequently and quickly a certain can gets full. Hygiea can also predict when it's time for a certain trash can to get full based on historical trends.
Recycle Track Systems	Custom, cost-effective waste and sustainability solutions using proprietary geolocation software, waste stream experts, and our powerful network of haulers.
RecycleGO	We provide software and hardware solutions to increase recycling and engagement in environmentally responsible behavior. We are building a recycling blockchain to track the end -of-life processes of recyclable commodities back into raw materials, and allow recyclers

	to properly account for their environmental impact.
Recyclops	Recyclops brings recycling to areas where it isn't traditionally available. By hiring independent contractors with pickup trucks and using a tech driven smart routing app we have been able to eliminate many of the logistical problems that kept recycling from happening in these areas.
Rubicon Global	We reduce waste and recycling costs for our customers, empower small businesses, and increase landfill diversion. Our goal is to create more sustainable solutions for businesses and the planet.
Trash Talk	Trash Talk makes waste and recycling collection greener by using smart sensors to monitor the fullness, location, and pickups of waste/recycling dumpsters and cans. TrashTalk aims to improve and increase recycling opportunities by making collection less expensive, and aims to reduce overall time of waste and recycling trucks on the road.
Zerocycle	The flagship product: a citywide, normative comparison report for both city officials and homeowners that compares recycling effectiveness by Neighborhood.

Others

Increased information transparency has already brought exciting new innovations that target supply chain management (Dipole), reduce fixed costs for hospitals (Cohealo), and optimize pricing for fresh produce to encourage sales and decrease organic waste (Wasteless.) As more awareness of Circular Economy needs and opportunities proliferates among the technology and investment community, there is expected to be further growth in information transparency oriented solutions.

Table 14. Information Transparency: Others

Cohealo	Cohealo enables hospital systems to increase the utilization of their medical equipment through proactive data analytics and equipment sharing. The Cohealo platform pinpoints redundant equipment that is underutilized, areas for rental avoidance, and ways to share resources between facilities.
Dipole	Dipole RFID solutions is dedicated to providing all of the services and support required in the effective acquisition of information and data pertaining to the actual status and condition of a product, item or article.
Foodprint Group	We help food businesses design Zero Waste into their operating practices by reducing waste and improving recycling.
H-Source	An online platform to allow hospitals and healthcare providers collaborate to recover costs, reduce spend and eliminate supply chain waste.
Isla Innovations	Isla Innovations develops circular business intelligence tools for decision makers and managers. We hold the position that the circular economy can be catalyzed in the US by making data related to circular economy and sustainability easier to manage for quicker and more accurate decision making.

Portico	Portico is an online tool used for the selection and specification of healthy products and materials for the built environment. Owned by Healthy Building Network, Portico was created in partnership with Google Real Estate and Workplace Services (REWS) team.
Reverse Resources	A Software as a Service (SaaS) platform for fabric and garment factories to map, measure and create visibility for leftover fabrics and scraps so that these become traceable through their following life cycles.
SheChange	SHEchange is a social enterprise working to aggregate consumer buying power to influence companies to adopt better policies and practices for a better world.
Wasteless	The Wasteless machine tracks the freshness of supermarket products and adapts the prices to their expiration date. Less fresh products become more appealing now because they are lower priced than the fresher one. Moreover, the supermarket increases sales and less waste is produced.

Case Study

Cohealo: Lowering Costs and Increasing Utilization Rates for Hospitals

Cohealo is a US-based technology company founded in 2012 that developed a cloud-based platform, which allows healthcare systems to schedule, track and share medical equipment. That's a big deal in the industry because health systems usually spend millions of dollars on purchasing and renting equipment, yet utilization rates for owned equipment are often below 50%. Because hospitals have limited resources and cannot afford to buy all available equipment, they will often rent equipment on a case-by-case basis. This can result in astronomical rental costs.

Additionally, hospitals do not have hard data on equipment utilization, making it difficult to determine whether the patient case volume exists to justify the purchase for new, cutting edge technology. From the beginning, Cohealo's founders believed that technology supported collaboration among hospitals could help to facilitate positive clinical outcomes and lower costs: "Our hospital partners are always working on ways that they can do more and better, with less," explained Brett Reed, co-founder and CEO at Cohealo.

Besides offering technological support to facilitate sharing, Cohealo works closely with customers on using the analytics generated from the platform for smarter, data-driven capital expense planning. With sharing in place, hospitals can collectively purchase a single piece of equipment, or make fewer purchases overall, because what a hospital might need is already in the network and has excess capacity.

Cohealo's model has a clear business case for itself and its customers, helping to push the industry towards more sustainable solutions. "Cohealo partners with hospitals to help solve for one of the most overlooked challenges in healthcare: how hospitals can make the most of their medical equipment. By allowing hospitals to share equipment between facilities, we've been able to deliver significant cost savings to our clients. Our sharing capabilities, as well as the resulting equipment utilization data, has been attractive to investors," said Reed.

Excerpted from World Business Council for Sustainable Development and The Boston Consulting Group, "The New Big Circle." January 2018. Pg 28. http://docs.wbcsd.org/2018/01/The_new_big_circle.pdf. Web. Accessed August 2018.

PRODUCT AS A SERVICE

Offering an alternative to ownership whereby the organization provides a service instead of selling a product

Product as a Service models make up 5% of the total number of Circular Economy initiatives in the database. These solutions are important to the development of the Circular Economy because they create higher utilization rates for goods and can create lower levels of resource use since consumers may no longer need to own a product. In some cases, they can also create the incentive for the manufacturer to invest in materials with higher durability as well as design for ease of repair.

Apparel and Consumer Goods

50% of Product as Service initiatives were focused on the Apparel and Consumer Goods industry. Shifting from ownership to leasing or product as a service models could yield enormous environmental impact due to the need to offset a forecasted increase in consumption rates spurred by a growing global middle class. Instead of feeding this new demand with business as usual models of increased production and resource use, we could instead develop new business models that encourage more sharing, rental, and reuse.

Table 14. Product as a Service: Reducing the need for Ownership in Apparel and Consumer Goods

Coozie Gear	Coozie Gear offers premium outdoor gear that is delivered and picked up at your door. We give you a smart alternative to buying, maintaining, and storing gear.
For Days	With a unique closed loop system, For Days is deeply committed to manufacturing innovation and waste reduction. We empower our members to free themselves from the burden of ownership and participate in a new OS for living.
HP Instant Ink	HP Instant Ink has a smaller environmental impact than buying ink in traditional ways because it reduces material consumption, energy usage, water usage, and carbon footprint of ink purchase and disposal.
Rent The Runway	Clothes end up in the back of closets or landfills. Power the sharing economy and rent instead.
SugaMat	Suga manufactures premium quality yoga mats in the USA from 100% recycled wetsuits. Offering a return service and life-time replacement warranty for their mats.
VF: Made for Change	Circular Business Models: This work includes a focus on branded rental and recommerce business strategies for its brands, in addition to emphasizing products that are designed to have a second life.

CASE STUDY

ECOLAB AND KNJAZ MILOS, UNDERSTANDING CHEMICAL LEASING

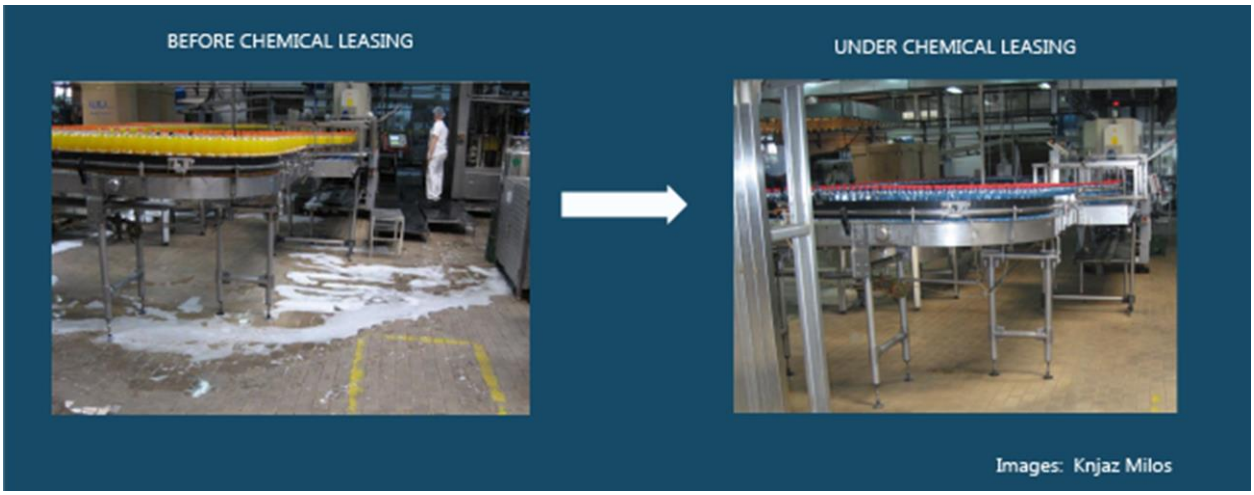
Chemical Leasing aims at promoting more efficient use of chemicals in the production process by redefining the business relationship between the chemical user and the supplier. In the Chemical Leasing model, the supplier does not sell quantities; instead, the supplier sells the function of the chemical. By doing so, the supplier no longer measures success according to the volume of chemicals sold. The supplier and the user both benefit because less chemicals are used when payment is linked to the functions performed. The life cycle of the chemicals is prolonged, waste is minimized and resources such as water and energy, can be used more efficiently. All of this contributes to the achievement of circular-economy goals.

Case Study: EcoLab and Knjaz Milos

In 2009, a beverage producer, Knjaz Milos, and EcoLab, a chemical's supplier based in St. Paul, introduced the Chemical Leasing model to their business relationship. Before adopting the Chemical Leasing model, Knjaz Milos had applied wet lubrication supplied by EcoLab to their conveyor belts to help reduce friction in the movement of their bottling process. This method had caused many problems: high consumption of chemicals, high consumption of water for dilution of the lubricant and cleaning, and high wastewater treatment costs.

Traditionally, beverage producers pay chemical suppliers per litre or per kilogramme of chemicals purchased. Under the Chemical Leasing model, Knjaz Milos stopped paying for chemicals according to volume and started paying according to the function of the chemical (lubrication) which was tied to running time of the conveyor belt.

Under Chemical Leasing, thanks to on-site technical support provided by Ecolab, Knjaz Milos was able to introduce dry lubrication and make enormous savings. For example, it was no longer necessary to use 3,500 cubic metres of water as had been the case for wet lubrication, and chemical consumption was reduced by half, from 6,000 to 3,000 kg.



Additional savings were made by virtue of the much-reduced need for transportation of chemicals (both import and inland operations), and an additional benefit was the reduction of carbon-dioxide emissions. Both partners benefited economically, and the quality of their long-term relationship greatly improved. They shared the mutual benefits and the formula for their success became "sharing - valuing - benefiting".

Condensed from "Chemical Leasing: an excellent tool for industry to implement the circular-economy approach to chemical operations" Grineva, Maria; Satric, Vojislavka, 5 July 2018. Retrieved from https://www.linkedin.com/pulse/chemical-leasing-excellent-tool-industry-implement-approach-grineva/ .Web. Accessed August 2018

Transportation

Providing solutions for transportation account for 41% of product as a service models. Product as a service in this sector provides the service of mobility without the need for ownership of a car, bike, or scooter. The auto industry is ripe for disruption as the average car is parked 93.6% of the time even during waking hours.[vi] Already, ride sharing has proved to reduce car purchasing among users. A 2017 Lyft study found that 250,000 of their ride sharing passengers have sold their personal car or abandoned replacing their current car due to the availability of ridesharing services.[vii] However, these types of solutions also have the potential to reduce the utilization of public transportation. A survey conducted by the University of California, Davis found that ride sharing services resulted in a 6 percent reduction in Americans' usage of bus systems.[viii]

Table 15. Product as a Service: Disrupting Transportation

Hytch	Carpooling app.
Jump	Bike sharing for electric bikes
Motivate (Acquired by Lyft as of July 2018)	A full-service bike share operator and technology innovator, Motivate currently manages all of the largest bike share systems in the United States and many of the largest systems in the world.
Uber Pool	Car sharing and car pooling
Via	Passengers request rides through a mobile app and Via's sophisticated algorithm instantly finds a vehicle that best matches their route, allowing for quick and efficient shared trips.

Real Estate

Product as a Service models for Real Estate are manifested by co-working spaces. Instead of needing to own or lease a fixed office space, co-working spaces can ideally provide greater flexibility and lower costs to customers with better utilization of space.

Table 16. Product as a Service: Disrupting Real Estate

We Work	WeWork transforms buildings into beautiful, collaborative workspaces. Get the space, community, and services you need to make a life, not just a living.

DESIGN

Focusing on the design phase of products, systems, or materials to enable better reuse, repair, recycling and/or incorporate less material usage.

Design is an important component of every theory of change and this section looks specifically at those initiatives where design is the main focus. 4% of initiatives in the database had a specific focus on design. Consulting firms with a Circular Economy focus were also included in this category.

Table 17. Design Initiatives

Biomimicry Institute	Our goal today is for biomimicry to become a natural part of the design process. We accomplish this by tackling one massive sustainability problem at a time through our Design Challenges platform, mobilizing tens of thousands of practitioners with the support of the Global Biomimicry Network to solve the challenge, and then providing those practitioners with AskNature as a tool to begin the solution process.
Brooks Circular Economy	Advocating for businesses transforming their model to circular economy. Focusing on consumer awareness to provide demand-pull as businesses provide supple-push. Particular emphasis on sustainable fashion.
Cradle 2 Cradle Innovation Institute	The Cradle to Cradle Products Innovation Institute, a non-profit organization, administers the Cradle to Cradle Certified™ Product Standard.
DESi Consulting LLC	I help innovative and emerging companies working on sustainable innovation gain market traction. I am especially interested in bio-based materials, sustainable packaging, and alternatives to plastic fibers.
FWD Impact	Sustainability consultancy with a focus on circular business model innovation and the apparel/textile industries. Developers of the Circularity Roadmap for Apparel Brands (http://www.fwdimpact.com/circularity-roadmap/).
Global Green	Global Green USA works in partnership with public agencies, communities, design innovators, and other nonprofits to create innovative and replicable policies, programs and procedures that make sustainability the standard during the planning, design, construction and operation of a built environment.
Ideo CoLab	Bringing together like-minded organizations to understand and shape how emerging technologies will affect our world. Initially focused on Textiles and Food (with other industries to follow), this research area investigates circular business models and opportunities.
Plant Prefab	Plant Prefab is the first prefabricated home factory in the nation dedicated to sustainable construction, materials, processes, and operations. Plant manufactures custom and single/multifamily homes that are high-quality, healthy, and durable.
US Green Building Council	The U.S. Green Building Council is committed to a sustainable, prosperous future through LEED, the leading program for green

	buildings and communities worldwide.
Zero Waste Guidelines	The Zero Waste Design Guidelines address the crucial role that design plays in achieving NYC's ambitious goal, outlined in OneNYC, to send zero waste to landfills by 2030. Participants include AIA New York, Kiss + Cathcart Architects, Rockefeller F., Closed Loops, Foodprint Group

FINANCING

Providing funds and investor support

There are hundreds of social impact funds in the United States focusing on a broad range of issues including economic inclusivity, clean energy, and providing access to basic needs. The ones below were selected based on their focus in funding Circular Economy related solutions. Investment firms made up 3% of the initiatives in the database.

Table 18. Financing for the Circular Economy

Alante Capital	Investing in the future of Sustainable Apparel
Closed Loop Fund	Closed Loop Partners invests in sustainable consumer goods, advanced recycling technologies, and the development of the Circular Economy.
Ecosystem Integrity Fund	The Ecosystem Integrity Fund ("EIF") is a venture capital firm that invests in early-stage companies contributing to environmental sustainability.
Prelude Ventures	We partner with inspired entrepreneurs who share our passion for technology innovation as a means to reduce global CO2 and believe that the best way to truly make a difference is to build successful companies.
Sidewalk Labs	By combining people-centered urban design with cutting-edge technology, we can achieve new standards of sustainability, affordability, mobility, and economic opportunity.
Structure VC	Our portfolio companies span a range of verticals, but they have one thing in common: they strive to eliminate waste.

GOING FORWARD

As evidenced by the preceding pages, there is already a multi-faceted ecosystem of solutions and organizations that are laying the groundwork for the creation of a Circular Economy in America and internationally. Of course, in order to reach a truly sustainable economic system, more innovations, partnerships, and business models still need to be developed, implemented and funded. Below are three areas to consider when thinking about future Circular Economy developments in America.

Thinking Beyond the Second Life Cycle

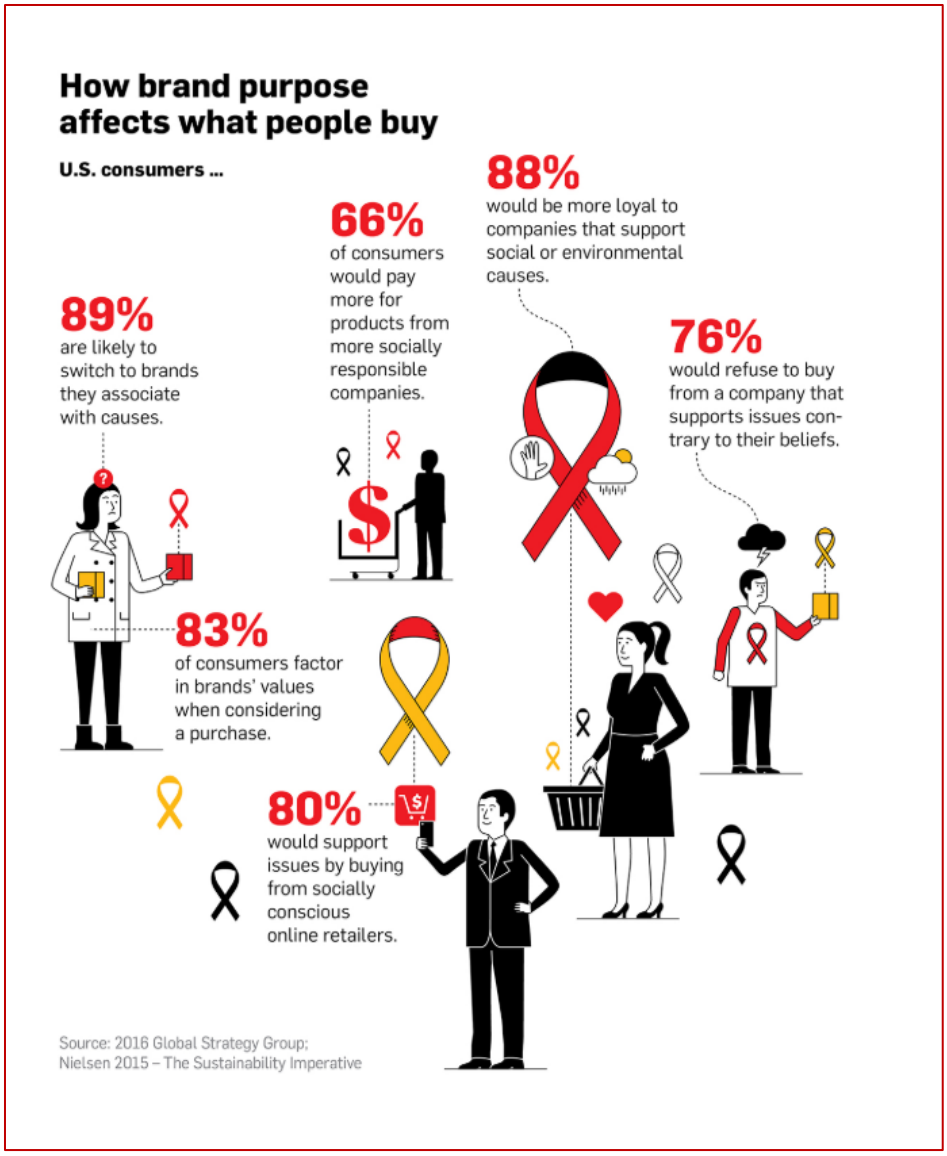
For companies focused on selling physical products, developing more product recirculation opportunities and/or better consumer education on proper end-of-life disposal for products presents both an economic and environmental opportunity. Of the companies in the database that sold physical products, less than 40% had information on their websites educating consumers on proper end-of-life disposal of their products; with less than 8% offering take back or disposal options. Even for organizations that had business models focused on the secondary market such as those that repurposed waste to create new consumer products, sold secondhand goods, or specialized in remanufacturing; providing recirculation opportunities for their products beyond the second life cycle was not a service that many organizations offered. If even these sustainability minded businesses are not considering end-of-life or recirculation options, this means the majority of consumer goods brands will have no awareness of the need for further product recirculation.

From an economic perspective, including education around end-of -life disposal or reuse alternatives offers purposeful engagement opportunities with existing consumers that are increasingly concerned about their environmental footprint. There may also be untapped revenue generation potential for businesses that examine options for incorporating post-consumer material back into their product line. Even if revenue opportunities are not tremendous, creating take back or post-consumer waste programs as part of a sustainability mission can lead to better employee engagement and loyalty.

From an environmental perspective, recirculating products presents a huge opportunity to magnify impact as virgin resources and many production processes can be conserved. Prolonging the recirculation of goods to the third or even fourth life cycle presents a significant step to drastically reduce environmental impact. This is because the amount of resource and energy use that goes into the production and manufacturing of materials and goods can be completely eliminated. The longer we can keep an item in circulation, the higher the life-time utility of that product becomes. Thus, organizations that can develop business models to service more people with less resource use will see both revenue and social benefits.

For-profit social enterprises will lead the way

Of the 202 initiatives in the database, 56% were start-ups or SMEs. As consumers continue to place greater demands on corporations to act as good corporate citizens (refer to the infographic below) the number of these types of for-profit social enterprises is expected to increase. In addition, as demonstrated by the growing B-Corp movement, there is a trend among the entrepreneur community to build companies that incorporate environmental and social considerations into their business model.



Wander, Eric "Infographic: What Consumers Expect of Brands When It Comes to Issues They Care About" 15 April 2018 https://www.adweek.com/brand-marketing/infographic-what-consumers-expect-of-brands-when-it-comes-to-issues-they-care-about/. Web. Accessed August 2018

Unlike many larger corporations, most of these social enterprises have social and environmental goals engrained into their DNA from their founding. This creates an alignment with their internal processes ranging from sourcing needs to labor practices to material selection to sustainability goals.

Conversely, most multinationals are still struggling with how to do "less bad" and have entrenched business practices or processes that hinder the adoption of new technologies and business models. Indeed, in interviews with corporate leaders serving on sustainability coalitions, there are certain topics that are often considered too taboo to mention if they can have an impact on the bottom line. Going forward, it will be interesting to see how corporate giants cooperate as well as compete with mission driven start-ups.

We Need More Radical Alternatives and Community Engagement

Most of the initiatives in the report are addressing needs within our current economic model. These solutions are very important in the short and medium term to create more sustainable resource use, extend the life-cycle of products, recirculate materials and so on. But a shift to a truly circular economy will also require completely new systems for delivering value.

For example, what if we moved from an economy based on the delivery of designs instead of physical product? Instead of buying a product, we would purchase the 3-D blueprint, go to a neighborhood lab that uses locally generated waste material as feedstock, and print our custom product. Once the useful life of the product was over, the material in the product would be processed back into feedstock for the community to re-utilize. This would create a closed loop system for not just physical material but also for local wealth creation.

In the above example, the barriers are not necessarily technology; we do have 3-D printing and even chemical recycling is available for many materials. The obstacles have more to do with the difficulty in creating true systems level change which necessitates participation from a broad array of stakeholders. In order for the Circular Economy to come to fruition, it will be critical to engage with stakeholders outside the traditional sustainability community.

QUESTIONING CONSUMPTION

According to the United Nations International Resource Panel (IRP), if increased consumption is met with today's business models, even with the continuation of current patterns of relative resource decoupling, resource use would triple by 2050 compared to a 2000 baseline (Fischer-Kowalski et al. 2011). Planetary boundaries research, however, shows us that we do not have the capacity for a tripling of resource use (see Box 2). Something has to give. Whether we see this growth in prosperity therefore depends on the extent to which economic growth—which is needed for human well-being—can be decoupled from both resource use and environmental impact. The IRP has outlined three scenarios for resource use in 2050 (adapted for Figure 4). Four categories of primary raw materials are included: construction minerals, ores and industrial minerals, fossil fuels, and biomass.

▪IRP SCENARIO 1. Resource use per capita in industrialized countries stabilizes at 2000 levels, and the resource use per capita of developing countries achieves the levels of industrialized countries. **Annual global resource extraction would triple**. According to the IRP, available resources would be exhausted, and **the planet would likely be unable to absorb the resulting environmental impacts.**

▪IRP SCENARIO 2. In this scenario, industrialized countries reduce per capita resource use by half between 2000 and 2050, for an overall absolute reduction. All other countries increase their per capita resource use to the now reduced resource use levels of industrialized countries. Resource extraction globally would increase by about 40 percent. To achieve this scenario, considerable innovation would be needed to significantly increase resource productivity.

▪IRP SCENARIO 3. With the third IRP scenario, global resource consumption in 2050 would be at 2000 levels. Industrialized countries would reduce resource use by a "far-reaching" factor of three to five. Developing countries would reduce resource use by 10 percent to 20 percent. Given population growth, environmental stresses would be comparable to today. This scenario is consistent with the per capita GHG emissions recommended by the Intergovernmental Panel on Climate Change to limit warming to no more than 2°C, but concerns about the potential to restrict development will make it challenging (Fischer-Kowalski et al. 2011). **The spirit of this scenario is one of unprecedented innovation. It suggests that in addition to the necessity for developed countries to scale new models of consumption that significantly reduce resource use, developing countries will also need to harness ingenuity to leapfrog over today's outmoded systems.** To put Scenario 3 into perspective, for a company to maintain product volumes (assuming the "far reaching" reduction in resource use in industrialized countries), a product designer would design a product (e.g., a T-shirt, a microwave oven, a toy) with 75 percent less resources across the entirety of the product life cycle, from extraction through manufacture, use, and end-of-life treatment.

This is a daunting task indeed. New technologies, cradle to cradle, and circular manufacturing models (see Box 4) would need to be scaled significantly. Another approach to accomplish Scenario 3 would be to reduce product volumes. Halving the number of products purchased, for example, has the potential of halving the resource efficiency challenge. Product longevity and business transformation to, for example, the sharing economy and product-as-a-service business models would need to be scaled.

Excerpted from *The Elephant in the Boardroom: Why Unchecked Consumption is Not an Option in Tomorrow's Markets.* World Resources Institute Pg. 9 (2017) Retrieved from http://www.wri.org/publication/elephant-in-the-boardroom .Web. Accessed August 2018

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Gina has a BA in international relations from the University of Pennsylvania and an MBA from Columbia Business School. She is confident that social entrepreneurs will change the world and is a judge for the Echoing Green Fellowship Program and a Mentor for the Mentor Capital Network. She is motivated by a love for nature and all wild things.

ABOUT CIRCULAR COLAB

Circular CoLab is an organization dedicated to supporting Circular Economy innovators in America. We believe that the greatest human innovation of this century will be learning to live in harmony with our natural ecosystem. For further information, please visit www.circularcolab.org