ACHIEVING A CIRCULAR ECONOMY:

How the Private Sector Is Reimagining the Future of Business

U.S. CHAMBER OF COMMERCE FOUNDATION
Corporate Citizenship Center

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U.S. CHAMBER OF COMMERCE FOUNDATION

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Going in Circles: How the Private Sector Is Leading the Circular Economy Revolution

By Jennifer Gerholdt, Director, Environment Program,
Corporate Citizenship Center, U.S. Chamber of Commerce Foundation

Today's linear economy—in which, quite simply, natural resources are extracted from the ground, made into products, used, and thrown away—was highly successful in delivering economic development during the 20th century. However, global trends indicate that the traditional, linear model's ability to produce economic growth is being increasingly challenged, prompting a search for alternative approaches that can work in the long term.

As a result of our throwaway society, natural resources are being depleted at an accelerating rate, and the ecosystems on which business and society depend are being degraded or destroyed. With upward of 9 billion people on the planet by 2030—including 3 billion new middle-class consumers entering the global market—the challenges of meeting the increasing demand for goods and services will be unprecedented.

Between 2002 and 2010, commodity prices rose more than 150%, erasing average price declines over the past century.[1] Another feature of today's business landscape is the rising volatility of commodity prices, which can have a devastating impact on companies that, due to high fixed costs, rely on economies of scale. If we continue with the business-as-usual approach, companies and society will witness a probable surge in price volatility, inflation of key commodities, and an overall decline—and in some cases, depletion—of critical material inputs.

The good news is that companies are actively pursuing alternative approaches to the linear take-make-waste model that decouple economic growth from resource constraints—such as the circular economy. This concept has captured the attention of many companies that see the economic opportunities of a viable model to successfully tackle sustainability challenges; drive performance, competitiveness, and innovation; and stimulate economic growth and development.

The circular economy is an industrial model that is restorative or regenerative by design and intent: products, components, and materials are kept at their highest value at all times. It is a system geared toward designing out waste; it looks at all options across the entire chain in order to use as few resources as possible in the first place, keep those resources in circulation for as long as possible, extract as much value from those resources, and then recover and regenerate those materials and products at the end of that particular useful life.

At the U.S. Chamber of Commerce Foundation Corporate Citizenship Center, we showcase how companies are contributing business solutions to society's challenges. In this report, in collaboration with The Ellen MacArthur Foundation, we are pleased to present a collection of best practices and approaches for how companies are leveraging the environmental, economic, and social opportunities the circular economy provides—how they are doing it profitably. Examples include:

- **HP**: Shifting from selling products to delivering higher-value services, such as its Managed Print Services and ink-subscription service, as well as its first-of-its-kind closed-loop print supplies recycling program.

1 http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf

- **Philips**: Applying circular economy principles to advance its business models that create value and gain market share, including providing lighting as a service and refurbishing healthcare imaging systems.
- **SunPower**: Integrating circular thinking into product design, manufacturing processes, and business models, such as designing modules for durability and recyclability, and leveraging Cradle-to-Cradle certification.
- **Tetra Pak**: Through the lens of renewability, leveraging circular economy principles to guide best practices around sourcing and use of raw materials at the beginning of a package's lifecycle.
- In addition, we are pleased to feature the work and thought leadership of other organizations making important contributions and advancements to the circular economy approach, including Accenture, Arizona State University, City of Phoenix, and the Closed Loop Fund.

A shift toward the circular economy could generate, by 2025, an estimated $1 trillion annually in economic value, create more than 100,000 new jobs, and prevent 100 million tons of waste within the next five years,[2] while restoring the natural capital and ecosystem services that are the foundation of healthy societies and economies globally. The examples in this report illustrate how it can be done. We hope you will join us.

2 http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf

CHAPTER 1: THOUGHT LEADERSHIP

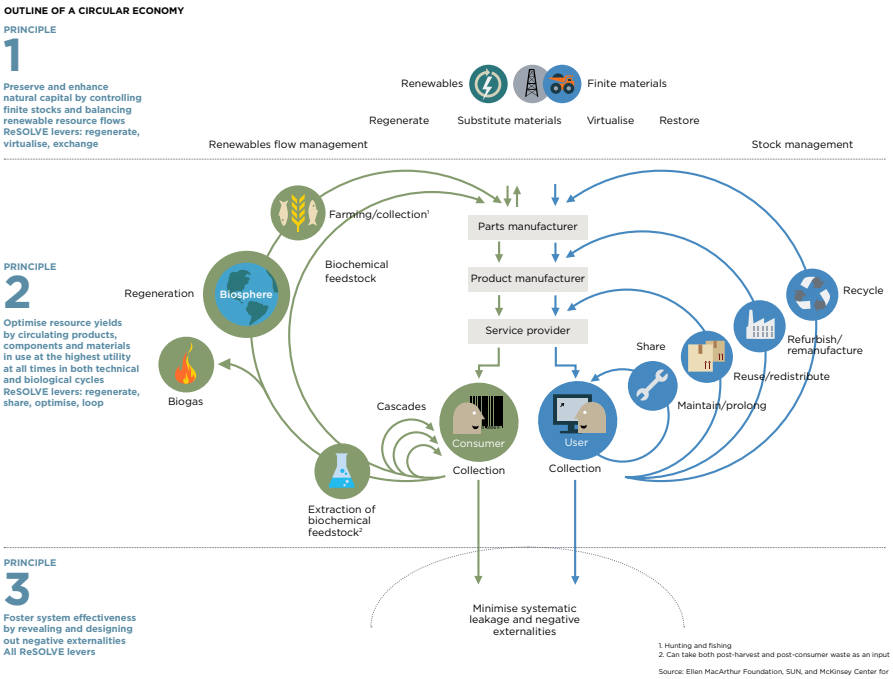
Planet

The Circular Economy Opportunity

By Andrew Morlet, Chief Executive Officer,
The Ellen MacArthur Foundation

Inherited from the Industrial Revolution and constantly refined since, our current economic model relies on a "take, make, dispose" one-way logic, which has proved hugely successful, fueling unprecedented economic development throughout the 20th century. Yet this extractive and linear pattern is increasingly challenged by the very context in which it operates, while powerful disruptive trends are converging to provide a great window of opportunity to redesign our value creation mechanisms.

Uncertainty on commodity markets, demographic pressure, changing user and consumer attitudes, quantum leaps in information technology capabilities…It would seem that the "rules of the game" for our economy are changing, and business leaders, innovators, academics, students as well as scientists are looking for a positive way forward—a new model through which we can rethink progress in the 21st century. The circular economy framework has been gaining traction around the world in recent years, buoyed both by its promising perspectives in terms of business benefits and by its array of positive societal and environmental impacts. Such a system is regenerative and restorative by design, and primarily relies on optimizing two distinct material flows: biological and technical. Products and services in this model are designed to enable efficient circulation, with biological materials returning



to the food and farming system (thus rebuilding natural capital), and technical materials being kept in production and use loops without loss of quality. A circular model generates new revenue streams and maximizes asset utilization while ensuring, as leading Performance Economy thinker Walter Stahel puts it, that the "goods of today become the resources of tomorrow, at yesterday's prices."

As well as the decline of cheap materials or questions around fossil energy availability and use, other changes under way are supporting the transition toward a circular economy. Testament to this is the momentum behind the "sharing economy" and the number of new businesses founded on creating visibility of idling capacity of a range of assets. Empty rooms can be booked through Airbnb, journeys through Lyft or ZipCar, power tools or sporting goods through local platforms—it's all about having access to the service that assets and goods provide, hence maximizing their use and offering an alternative to outright ownership. Clothing company Le Tote provides access to women's fashion for a flat monthly fee in the same way that people use streaming platforms instead of owning physical media. Technological advances are facilitating these business models: finding and booking the nearest shared car or bike has only been made convenient with smartphones, mobile networking, and real-time data management. Product tagging and tracking, and the growing "Internet of Things," are also enabling manufacturers and service providers to keep an eye on their products, to tell how much they're being used, and to determine if they're performing properly and when they're about to go wrong. This makes product recovery feasible, opens up new customer service or aftermarket opportunities, and optimizes material flows to enable remanufacturing or repurposing.

Global trends are providing a fertile environment for a shift in the economy, which could see growth gradually being decoupled from the consumption of finite resources and its associated negative externalities. And as our research shows, increasing circularity could offer a significant economic advantage. In 2012, the Ellen MacArthur Foundation published the first in a series of reports titled *Towards the Circular Economy,* featuring analysis by McKinsey & Co. These reports have concluded that a circular economy would represent an opportunity in excess of $1 trillion. There are considerable net material savings to be achieved (up to $630 billion per year for Europe alone) through improvements in design, business models, reverse cycles, and system conditions, such as education and policy. Our latest analytical effort shows how circular economy principles can maximize the benefits brought about by the impending technology revolution and, in the case of Europe, double that positive impact to generate a net benefit of €1.8 trillion by 2030. Looking at housing, mobility, and food, we have demonstrated that the circular economy would also have significant impacts on the environment, as carbon dioxide emissions would halve by 2030, relative to today's levels.[3] These compelling figures make a strong case for an accelerated transition, and they capture the imagination of policymakers and business leaders alike.

There are already promising signs of a shift taking place; however, reaching this goal will require pioneering ambition combined with varied collaboration to deliver the benefits of a truly circular system that rebuilds economic, social, and natural capital. Such a transition obviously cannot happen overnight, and setting milestones along the way is essential for companies that would wish to build on existing efficiency-driven strategies and upgrade to circular practices. There is a wide variety of initiatives (some already quite advanced, others just emerging) but, in all cases, the most important thing is to a have a precise sense of the objective in order to ensure a clear direction of travel—a straight line to circularity, so to speak.

3 All figures are for European Union. Source: Growth Within: *A Circular Economy Vision for a Competitive Europe*. Ellen MacArthur Foundation, in collaboration with the McKinsey Center for Business and Environment, and the support of SUN (Siftungsfonds für Umweltökonomie und Nachhaltigkeit). 2015.

Innovative Business Models Enabling the Circular Economy

By Jennifer Gerholdt, Director, Environment Program,
Corporate Citizenship Center, U.S. Chamber of Commerce Foundation

The shift to the circular economy requires companies to rethink more than just their use of renewable energy and toxic chemicals and their resource footprint to capitalize on the benefits the circular economy offers. It requires a redesign and adoption of innovative business models based on dematerialization, longevity, remanufacturing, refurbishment, capacity sharing, and eventual recycling.

Accenture, a global management consulting, technology services, and outsourcing company, has identified five circular business models[4] companies can leverage—singly or in combination—to generate resource productivity improvements in innovative ways that also cut costs, generate revenue, and enhance customer value and differentiation. Let's take a closer look at these models and some of the corporate leaders who are on the forefront of the transition to the circular economy.

1. Circular Supply-Chain: The Circular Supply-Chain model, in which scarce resources are replaced with fully renewable, recyclable, or biodegradable resource inputs, is particularly relevant for companies dealing with scarce commodities. Royal DSM has developed cellulosic bioethanol, in which agricultural residue (baled corn cobs, husks, leaves, and stalks) is converted into renewable fuel.[5] The cellulosic bioethanol created a new source of revenue for DSM while reducing emissions, creating jobs, and strengthening national energy security.

2. Recovery & Recycling: The Recovery & Recycling model leverages technological innovations and capabilities to recover and reuse resource outputs; it eliminates material leakage and maximizes economic value. Examples include closed-loop recycling, industrial symbiosis, and Cradle-to-Cradle® designs, whereby waste materials are reprocessed into new resources. Walt Disney World Resort sends food waste—including grease, cooking oils, and table scraps—from select restaurants in its complex to a nearby 5.4 MW anaerobic digestion facility owned and operated by Harvest Power.[6] The organic waste is converted into renewable biogas (a combination of carbon dioxide and methane) to generate electricity, with the remaining solid material processed into fertilizer. The energy generated is used to help power central Florida, including Walt Disney Resort's hotels and theme parks.

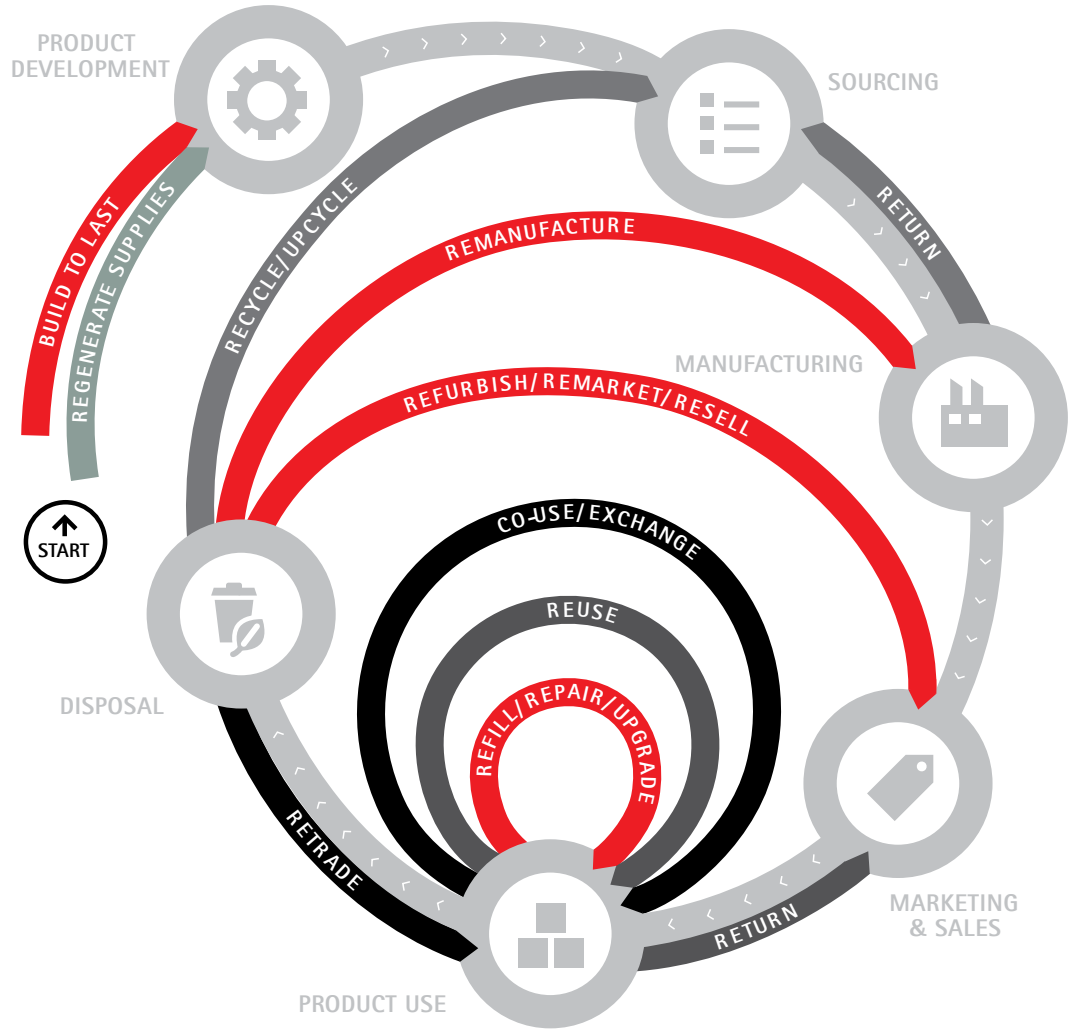
3. Product Life-Extension: The Product Life-Extension model helps companies extend the lifecycle of their products and assets to ensure that they remain economically useful. Material that would otherwise be wasted is maintained or even improved, such as through remanufacturing, repairing, upgrading, or remarketing. By extending the lifespan of the product for as long as possible, companies can keep material out of the landfill and discover new sources of revenue. Over the past 40 years, Caterpillar's remanufacturing activity, through its Reman Program, has focused on returning components at end of life to same-as-new condition

4 Peter Lacy and Jakob Rutqvist, Accenture, "Waste to Wealth: Creating Advantage in a Circular Economy," September 2015, https://www.accenture.com/us-en/insight-creating-advantage-circular-economy.aspx

5 http://www.dsm.com/corporate/about/business-entities/dsm-biobased-productsandservices.html

6 https://thewaltdisneycompany.com/citizenship/act-responsibly/environmental-stewardship/performance#waste_

The five circular business models



or quality, which reduces costs, waste, greenhouse gas emissions, and need for raw inputs.[7]

4. Sharing Platform: The Sharing Platform model is centered on the sharing of products and assets that have a low ownership or utilization rate. This is particularly attractive in developed economies where a typical car is used 5% to 10% of the time and up to 80% of goods stored in a typical home are used only once per month.[8] Companies that leverage this model can maximize the use of the products they sell, enhance productivity and value creation, and create new relationships and business opportunities. Examples of the sharing economy abound, including transportation (Lyft, RelayRides, BlaBlaCar), lodging (Airbnb), and neighbors helping neighbors (TaskRabbit, NeighborGoods).

5. Product as a Service: Through the Product as a Service model, customers use products through a lease or pay-for-use arrangement versus the conventional buy-to-own approach. This model is attractive for companies that have high operational costs and the ability to manage maintenance of their service and recapture residual value at the end of life. Philips sells lighting as a service: they aim to reach more customers by retaining ownership of the lights and equipment so customers do not have to pay the upfront costs of installation.[9] Philips also ensures the sound environmental management of their products by taking them back at the appropriate time for recycling or upgrading.

Accelerating and scaling up of the circular economy on a global level will require a combination of business models like these, technological advancements and innovation, and collective action across different stakeholders, industries, and geographies. With the world rapidly changing, resources becoming more scarce and expensive, and consumer preferences and expectations shifting, there is no time like today to capitalize on the transition to the circular economy—an opportunity worth in excess of $1 trillion for the global economy.[10]

7 https://catreman.cat.com/

8 http://fortune.com/2015/01/20/the-huge-challenges-and-opportunities-of-the-circular-economy/

9 http://www.lighting.philips.com/main/services/

10 http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf

Ten Disruptive Technologies

By Jessica Long, Managing Director, Accenture Strategy, Sustainability

New business models offer companies powerful options for embracing the circular economy.[11] But it would not be possible to scale many of these business models without the support of 10 innovative technologies.

1. Mobile: Mobile technology enables universal and low-cost access to data and applications. As consumption behavior goes mobile and online, it reduces the need for physical resources that range from paper and entertainment to stores.

2. Machine-to-Machine (M2M) Communication: M2M technology has long been used in factory control systems and vehicle telematics. Now we're about to reach a critical mass for mainstream M2M use as wireless network coverage expands worldwide.

3. Cloud Computing: Dematerialization—the process of replacing something physical with a digital alternative—is enabled by cloud computing, which threatens entire industries (e.g., travel agents, music stores).

4. Social: Social technology reduces the cost of setting up sharing platforms, as it allows businesses to tap into existing networks. It makes it cheaper and quicker for companies to receive consumer feedback in order to help improve offerings.[12]

5. Big Data Analytics: In the circular economy, many companies will generate their revenues from product use instead of sales. Growth will rely on how good they are at understanding and catering to product use behavior.

6. Modular Design Technology: Modular design technology is revolutionizing not only how products function but also the length and nature of customers' relationships with those products. When a modularly designed product breaks, only the defective part is replaced or repaired extending its overall product lifecycle.

7. Advanced Recycling Technology: While recycling is not at all new, it has benefited from a great deal of innovation and some significant, rapid returns on circular economy investments.

8. Life and Material Sciences Technology: Ongoing innovation in life and material sciences will lead to new circular material input options at scale. It will also enable new ways to alter outputs so they can be used as inputs.

9. Trace and Return Systems: Trace and return systems support circular business models by making it more cost-effective to collect used products in order to service, repair, recover, reuse, refurbish, or recycle them.

10. 3-D Printing: 3-D printing is evolving to become a major player in the manufacturing world, driving circular business models. It facilitates repairing and creates opportunities for circular inputs that are biodegradable or infinitely recyclable.

11 Peter Lacy and Jakob Rutqvist, Accenture, "Waste to Wealth: Creating Advantage in the Circular Economy," September 2015, https://acnprodedit.accenture.com/sitecore/content/core/Home/BucketContent/46/insight-creating-advantage-circular-economy.aspx?sc_mode=preview&sc_lang=en

12 Accenture, "Accenture Technology Vision 2013: Every Business Is a Digital Business," https://acnprod.accenture.com/us-en/insight-tech-vision-2015-internet-me-video

Advancing a Circular Economy Starts with Collaboration—And It Starts Now

By Neil Hawkins, Corporate Vice President for Environment, Health and Safety (EH&S) and Chief Sustainability Officer, The Dow Chemical Company

The world's population is expected to reach 8.3 billion by 2030. In order to ensure that future generations are afforded the basic necessities, we will need 50% more food, 45% more energy, and 30% more water. But producing more is not enough. We must work collectively to use our precious resources wisely and change our behaviors to ensure a sustainable planet for all generations to come.

At Dow, we believe that a circular economy is part of the solution. Instead of the linear "take-make-dispose" approach, a circular economy will, by design, keep products and materials at their highest utility and value, enable service life extension, and value ecosystems throughout their lifecycles. Innovation, collaboration, and ingenuity will enable higher material and resource efficiency, promote redesign of products and value chains, and create new business models.

Dow also recognizes that chemistry is a key part of enabling a circular economy. In fact, the business of chemistry contributes to 96% of all manufactured goods.[13] We have long been committed to creating sustainable solutions for some of the world's greatest challenges, and we will continue this commitment as we work toward our 2025 Sustainability Goals. Over the coming decade, Dow will collaborate with other leaders in business, NGOs, and government to deliver six major projects that facilitate the world's transition to a circular economy, where "waste" is designed into new products and services.

Powerful examples are in play today: Dow Terneuzen, Dow's largest chemical processing plant outside of the United States, is in a major seaport and freshwater-scarce coastal area in the Netherlands. The plant faces competing water demands across agriculture, industry, and residences, ultimately making water management difficult. To help manage freshwater use and reuse on site, Dow has collaborated with private-sector companies and the city of Terneuzen to implement a program in which Dow Terneuzen accepts wastewater each day from the city, has it purified by a third party, and reuses it for its industrial processes. As a result, the site reuses 30,000 cubic meters of municipal wastewater each day and has reduced its energy use by 95%—the equivalent of reducing carbon dioxide emissions by 60,000 tons each year and a savings equal to planting more than 1.5 million tree seedlings over the course of a decade.[14]

13 http://www.americanchemistry.com/chemistry-industry-facts

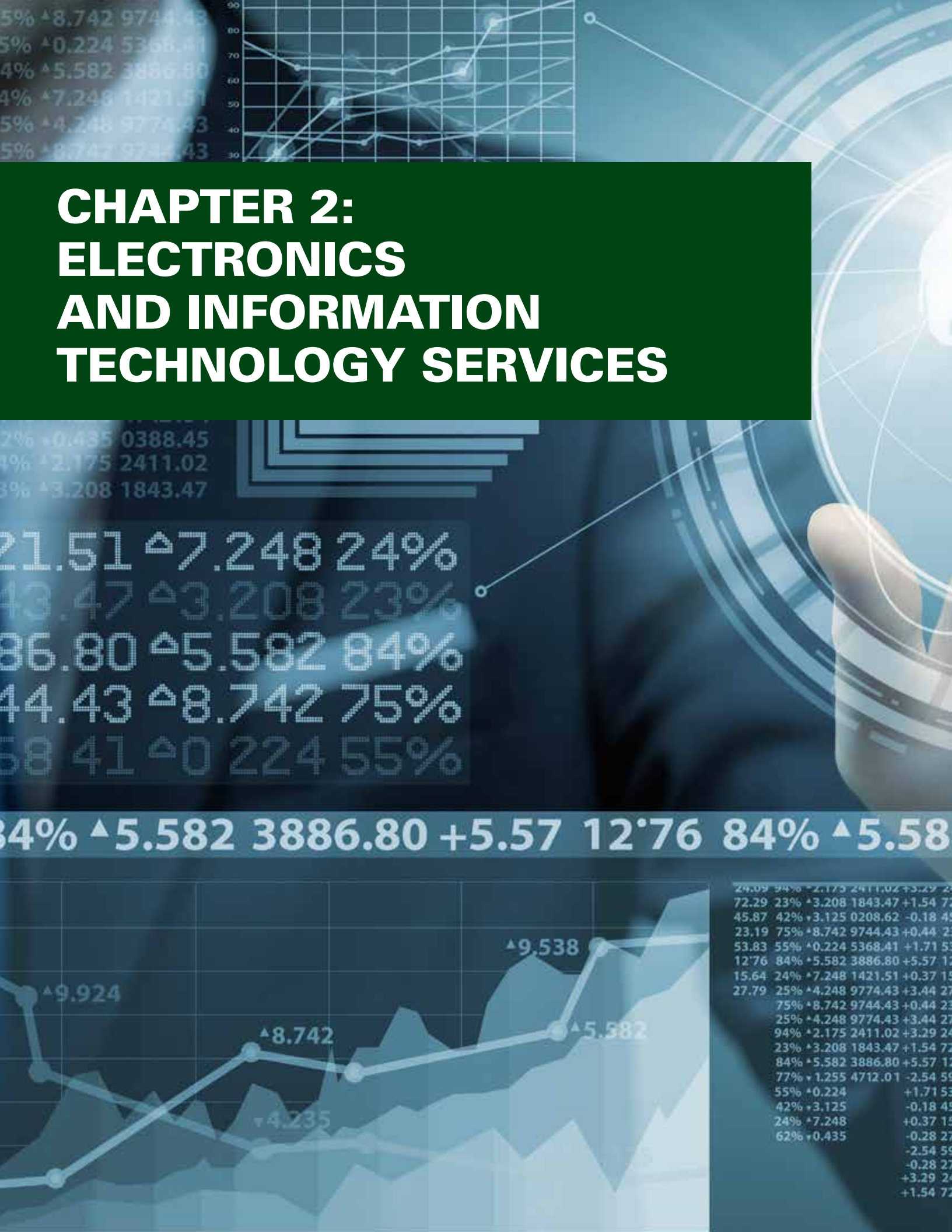
14 http://www.epa.gov/cleanenergy/energy-resources/calculator

Circular economy opportunities also exist at the intersection of waste and energy. Despite the continued expansion of recycling programs, more than half of the waste in the United States—one-fifth of it plastic—still goes to landfills. Collaborating across the public and private sector, Dow set out to recover the embedded energy content of nonrecycled plastic waste in Citrus Heights, California. The first of its kind in the United States, the 2014 Energy Bag Pilot Program demonstrated that nonrecycled plastics can be collected and converted into a usable energy source, like synthetic crude oil. For three months, the citizens of Citrus Heights collected previously nonrecycled plastic items in bright purple "Energy Bags" to be picked up on their recycling collection day. Together, approximately three tons of nonrecycled items were diverted from landfills and converted into 512 gallons of synthetic crude oil. If implemented across the country, we could keep more than 4 million tons of waste out of landfills, enough to produce a *billion* gallons of fuel a year. While this wouldn't eliminate the need for hydrocarbon-based fuels, it would substantially reduce the amount of natural resources being tapped to serve the country's energy needs—advancing a circular economy.

There is a theme that carries through both of these examples: collaboration. A circular economy cannot be achieved by a single company or sector; it requires reexamining business' role in society and taking responsibility for areas traditionally outside our missions and balance sheets.

Dow recognizes that no one business, government, or NGO can do this alone. That is why we're encouraging others across the private and public sectors to come together and join us, as part of our 2025 Goals, to develop a societal blueprint that integrates public policy solutions, science, technology, and innovation to advance toward a more sustainable world.

Further progress in sustainability will require a collective, long-term effort. Let's work together, leveraging the best of what each of us has to offer, and realize the global opportunity before us.



CHAPTER 2: ELECTRONICS AND INFORMATION TECHNOLOGY SERVICES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Building a Waste-Free Tech Industry

By Trisa Thompson, Chief Responsibility Officer, Dell

Technology increasingly drives the global economy and daily life for consumers, businesses, and organizations. It is therefore critical that this sector be a leader in the shift to a circular economy. At Dell, we implemented a major redesign across our entire business—from product design and innovative packaging materials to smarter shipping and building the world's largest technology recycling program. We are also shifting to cloud-based services, virtualization, and other technologies that make it easy for customers to achieve their goals without acquiring as much physical "stuff."

Designing products and supply chains with the whole lifecycle in mind helps to ensure that physical materials can be more easily recovered and fed back into the circular system at the end of the original product's useful life. Creating a global closed-loop supply chain requires collaboration and new models. For instance, in partnership with Goodwill Industries, Dell collects used electronics of any brand via our Dell Reconnect program at more than 2,000 locations across the United States. The products are then delivered to Dell's Environmental Partner network for responsible reuse or recycling. Proceeds from the remaining value of the donation are reinvested to sustain the Dell Reconnect program and advance the closed-loop process.

Recovered materials from such programs can then be converted into new parts for new products. Since 2014, we have shipped over 11.35 million pounds of electronic products for recycling to environmental partners across our supply chain and have used over 4.2 million pounds of plastics back into our Dell products through mid-2015. These closed-loop plastics are used in 31 monitor models and three desktops that are available globally, including the Dell OptiPlex 3030 All-in-One desktop, which was the first UL Environment-certified closed-loop PC on the market. Dell sees product recycling and takeback as a critical part of the effort to move the circular economy forward and actively supports infrastructure development for recycling and the harmonization of approaches globally.

Product packaging offers another example that can be applied across industries. As part of our company-wide Legacy of Good Plan, Dell has committed to waste-free packaging by 2020. Today, two out of three products ship in sustainable packaging, and we plan to meet our 100% goal through a combination of recyclable and compostable materials. Wheat straw packaging is a unique way to convert what would be a waste product in traditional farming into a useful input for another industry. Boxes and cushions made from wheat straw are similar in look and performance to corrugated paper pulp cousins, but the process to create them uses 40% less energy and 90% less water. We have also used other innovative materials in packaging, including bamboo, mushrooms, and even plastics derived from methane emissions. Often Dell partners with innovative entrepreneurs to bring new sustainable solutions like wheat straw to market. These partnerships help both to validate innovative new solutions and to scale the materials globally.

We are transforming the way we design products and services, and we support a broader transition to sustainable business operations by offering tools, services, and education that can benefit the entire industry. Advancing a circular economy requires

that we all look beyond our walls to inspire better practices throughout our entire ecosystem. We must collaborate with innovative partners to fill the gaps in current supply chains and frameworks in order to make sustainability easier for customers and partners so that we can all start to close the loop on the circular economy in the IT industry and beyond.

eBay: Reuse and Redistribution at Scale

By Lori Duvall, Director, Global Impact, eBay

With 157 million active buyers globally, eBay is one of the world's largest online marketplaces. Whether buying new or used, plain or luxurious, commonplace or rare, if it exists in the world, it probably is for sale on eBay. Founded in 1995, eBay connects a diverse community of individual buyers and sellers, as well as businesses. The company also reaches millions through specialized marketplaces, such as StubHub, the world's largest ticket marketplace, and eBay classifieds sites, which together have a presence in more than 1,000 cities around the world.

eBay is a partner to our sellers. We build strong connections between people, with product experiences that make eBay fast, mobile, and secure. We are also transforming the individual selling experience to help people turn the things they no longer need into cash they can use.

eBay's vision for commerce is one that is enabled by people, powered by technology, and open to everyone—creating more economic opportunity for all.

Reuse and redistribution are key elements of a thriving circular economy, and we see eBay as one of the largest platforms for extending the useful life of products. Historically, this has been primarily enabled by peer-to-peer selling, but as online commerce (and eBay) has matured, this model has grown to support other parts of the circular economy model, including maintenance and repair through parts and accessories sales; local redistribution via our eBay Classifieds businesses; "service" models, such as textbook rentals on Half.com; and our eBay Wholesale B2B marketplace, which helps resellers source often "trapped" or idle inventory.

eBay believes its commerce platform is a unique asset that can drive innovation in and strategically support the transition to a circular economy. By leveraging our company's capabilities and scale in a strategic and intentional way, we aspire to create a more impactful engine for reuse and redistribution. In the peer-to-peer sector, focus areas include increasing the percentage of buyers that are also sellers and making it as easy as possible for people to extend the useful life of products. Outside of the peer-to-peer sector, the company sees great potential in scaling partnerships with brands that build products that can be passed on from user to user. We hope to learn—from the companies and organizations in this space—what other aspects of accelerating the transition to a circular economy eBay may be able to influence and support.

New Business Models for a Better Future

By Kristine J. Kalaijian, Director, Environmental Compliance and Sustainability, Philips North America

In 2050, approximately 9 billion people will live on this planet, all aiming for a good quality of life, health, and well-being. As the population continues to age, there is a growing demand for integral value-based healthcare solutions. Energy-efficient lighting is essential, driving progress toward digitalization and integrated lighting solutions.

Philips' three domains—Healthcare, Lighting, and Consumer Lifestyle—are positioned well to address these mega trends. In 2013, Philips adopted a fundamental rethinking of its strategies and defined a new mission and vision to make the world healthier and more sustainable with meaningful innovation, and it set the goal to improve the lives of 3 billion people a year by 2025.

As part of this commitment, Philips has been applying some of the principles of circular economy, where the more effective use of materials enables the creation of more value, by saving costs and developing new markets, or by growing existing ones.

Philips' circular business models create value and help gain market share.

Lighting as a Service

In this business model, Philips sells a service, not a product, focusing on maintenance and repair agreements and service support that provide technology upgrades, extending product life and enabling reuse.

In 2013, Philips signed a 10-year performance contract with the Washington Metropolitan Area Transit Authority (WMATA) to upgrade the lighting in 25 parking garages. Over 15,000 lighting fixtures were converted to an innovative, custom-designed LED solution that provides white light exactly when and where it is needed.

As a result, energy usage has been reduced by 68%, or 15 million kWatt hours, per year, and real-time data on energy consumption are now available. A first of its kind, the new Philips system not only makes the garages brighter and safer for WMATA's 66,000 parking garage customers, but also removes over 11,000 metric tons of carbon dioxide from the environment. Philips monitors and maintains the lighting solution, which is financed through energy cost savings—thereby requiring no upfront capital costs. Furthermore, Philips provides spare parts and extracts material value from end-to-life components through recycling.

Managed Services in Healthcare

Philips Healthcare's strategy is to enable healthcare providers to deliver lower-cost care with better outcomes through:

- Innovative business models, such as managed equipment services, and outcome- and solution-based models that avoid capital expenditure and focus on access to technology and functionality.
- Integral lifecycle management that provides options like upgrades, refurbishing, and reconditioning of hardware.

To date, Philips has more than 40 deep, long-term global partnerships with care providers, delivering such customer benefits as cutting MRI waiting times in half and reducing technology spending by more

than a third, all while improving clinical quality. Two such alliances here in the United States—most recently with Westchester Medical Center Health Network (WMC Health) and, in 2013, with Georgia Regents Medical Center (GRMC)—represent unprecedented multiyear enterprise partnerships ($500 million and $300 million, respectively). Healthcare providers invest in Philips Health System's leading imaging, patient monitoring, ultrasound and clinical informatics solutions, bridging products, consulting, and value-added services that include Philips Lighting and Personal Health as well. Under a unitary payment structure, Philips assumes the risks and accountability for the ownership, management, and maintenance of the medical technology.

Refurbishing Imaging Systems

Refurbished healthcare products offer medical facilities access to high-quality systems within budget. They also enable Philips Healthcare to reuse vital components, driving circular economy value creation.

In Best, Netherlands, we refurbish our MR, interventional X-ray, surgery, and CT equipment. In Cleveland, Ohio, and Bothell, Washington, we refurbish our PET/CT and SPECT scanners, and our ultrasound equipment, respectively.

Sold under the Diamond Select program, Philips' refurbished systems are used products that perform as if they were new; the same warranty conditions also apply. Our goal is to optimize the reuse of components while maintaining high-quality standards.

The establishment of refurbishment business allows Philips to optimize the collaboration between its design (R&D), production, and refurbishment groups. With reuse in mind, the design and development approach will be enhanced in order to reenter a maximum amount of preowned product elements into the production process once their first lifecycle ends.

Refurbished products are sold for 60% to 85% of the equivalent new system price. Philips' share in the Original Equipment Manufacturers (OEMs) refurbished equipment market is about 25%.At Philips, designing and delivering innovative solutions for a changing world is our mission and our passion because we believe the future can not only be different, it can be better.

Reinventing How Businesses, Supply Chains, and Whole Industries Work

By Judy Glazer, Global Head of Product & Service Sustainability, HP

Over the years, the IT industry has implemented sustainable business practices, including using less materials in products, reducing energy usage in the manufacture and operation of products, making products more recyclable, and developing end-of-life programs. HP believes that the IT industry is uniquely positioned to support the ideals of the circular economy by inventing more sustainable technologies and services.

HP is already driving toward this approach across its portfolio by designing out waste, improving product longevity, and developing solutions that keep resources in the value chain for as long as possible.

Delivering Higher-Value Services

HP's strategy is reflected in innovations such as its service-based solutions, which are reducing computing and printing footprints. These solutions include its Managed Print Services (MPS) and Instant Ink service, which help customers, large and small, save money, lower their environmental impact, and ensure responsible use and recycling.

Both offerings support HP's circular economy efforts by shifting the emphasis from selling products to delivering higher-value services. For example, MPS offers a customizable set of solutions—including devices, network print management software, supplies, support, and end-of-life hardware options—that reduce customers' printing-related energy usage 20%–40%, decrease costs 10%–30%, and lower paper waste 25% or more.

Instant Ink, HP's ink-subscription service, while reducing costs, ensures that consumers and small businesses don't run out of ink at the wrong time. Through the program, an Internet-connected printer notifies HP when it is running low on ink, and a replacement cartridge is automatically delivered. Customers can return the empty ink cartridges to HP in a prepaid envelope. By providing print as a service in this way, HP is reducing waste throughout the product lifecycle. In fact, ink subscription printers generate up to 67% less waste per printed page than do conventional business models.

One Million Water Bottles Saved a Day

HP's first-of-its-kind closed-loop recycling program for print supplies was designed in collaboration with key recycling and materials suppliers and partners. Through this program, returned ink cartridges are disassembled and separated into metals, plastics, and other materials. The plastics are then processed and mixed with plastics from other sources, such as used water bottles and plastic hangers, to create plastic for new cartridges.

Launched in 2005, this initiative has been enhanced over the years based on HP's growing expertise in materials development and reverse logistics. Changes include expanding the types of plastics used and shifting from a "shred and separate" process to a disassembly approach that has delivered a 50% increase in plastic recovery and a reduction in water and energy use.

In the past five years, HP has helped divert, on average, more than 1 million water bottles per day from landfills—and has used more than 3 billion bottles and 40 million apparel hangers to manufacture more than 2.5 billion ink cartridges. HP has used

more than 100 million pounds of recycled content material since the program began. Today more than 75% of original HP ink cartridges and 24% of HP LaserJet toner cartridges by sales volume use closed-loop recycled plastic. HP continues to apply lessons learned from programs such as this one to advance the way it designs other products to use recycled materials.

Designing for the Future

HP continues to invest in technologies it believes will significantly change the way people live and work. Those technologies include 3-D printing, which many believe will enable the circular economy to scale into other industries. For example, HP's commercial 3-D printers will eliminate waste by enabling fast, localized, customized, and accurate production of parts and finished goods. Because all products will be made to order, demand variations and obsolescence will decline rapidly, and repairs will become easier, faster, and less expensive.

HP has already seen the benefits of this type of model. By replacing analog printing with digital printing production, companies can reduce waste by up to 30% by better matching demand with production.

Moving from a linear economy to a circular one requires disruptive innovation. For more than 30 years, HP technologies have led printing technologies in many markets. Today, by collaborating and engaging the creative potential of others, HP looks to lead the development of solutions that will allow inventors to design and build systems whose form and function will surpass what can be imagined and manufactured today.

Business and Environmental Benefits of Resource Efficiency at IBM



By Edan Dionne, Kurt Van der Herten and Timothy Mann, Corporate Environmental Affairs, IBM

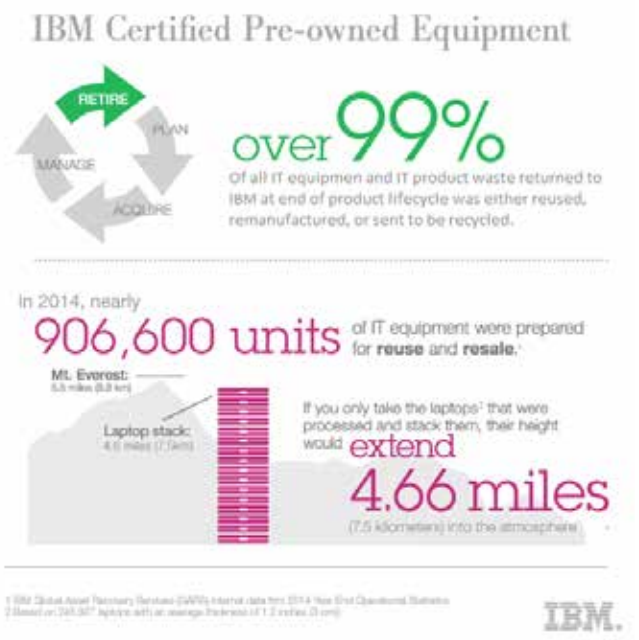
IBM is committed to environmental leadership in all of its business activities; its long history boasts more than 40 years of environmental accomplishment. First issued in 1971, IBM's Corporate Environmental Policy has been updated over the years. It calls for IBM to, among other things:

- Conserve natural resources by reusing and recycling materials, purchasing recycled materials, and using recyclable packaging and other materials.
- Develop, manufacture, and market products that are protective of the environment and that can be reused, recycled, or disposed of safely.

Consistent with its policy objectives, IBM formalized its Product Stewardship program in 1991 and has implemented practices that fully support and are in line with the ideas and goals of a circular economy. Ranging from designing products, to delivering computing and field services, and to recovering and reutilizing assets at their end of life, IBM's business embodies circular economy principles.

Product Design

IBM's Product Stewardship program is an integral part of its global environmental management system (EMS). It provides IBM's product and solutions development organizations with direction and goals, infrastructure, tools, and expertise to apply environmental lifecycle considerations from product concept through product end-of-life management. The objectives of IBM's Product Stewardship program include:



- Developing products with consideration for upgradeability, to extend product life and enable reuse and recyclability at the end of product life.
- Developing and manufacturing products that use recycled materials.
- Developing products that minimize resource use and environmental impacts through selection of environmentally preferred materials and finishes.

Corporate Goals

IBM has long leveraged goal setting—a component of its global EMS—to drive improvements. The table on the next page summarizes three examples.

Area (Year of Initial Goal)	Current Goal	2014 Performance
Use of recycled plastics (1995)	Incorporate recycled plastics in products equal to 5% of all plastics purchased	12.1%
Landfill and incineration minimization (2000)	Send no more than 3% of product end-of-life materials to landfill and incineration	Less than 0.5%
Nonhazardous waste recycling (1988)	Send 75% of waste IBM generates for recycling	86%

Equipment Maintenance and Services
Through its Technical Support Services business, IBM provides clients customizable hardware and software support services for IBM and multivendor systems. Depending on the client's needs, these can cover proactive prevention, warranty repairs, technology upgrades, and other services. This offering ensures longer lifetime, availability, and functioning of the equipment.

Asset Recovery and Reuse
In 1989, IBM began offering product take-back services for clients. Moreover, it had robust programs for remanufacturing and reuse of products returned from client lease arrangements for decades prior to 1989. Today IBM's Global Asset Recovery Services (GARS) organization applies a high level of business intelligence and analytics in the reuse and redistribution of its assets, including those assets managed for IBM's clients. This facilitates the maximization of reuse across the product lifecycle. Where possible, and so that these assets are kept at their highest utility and value, priority is given to reuse of whole equipment or its sub-assemblies before addressing the reuse of smaller parts and components.

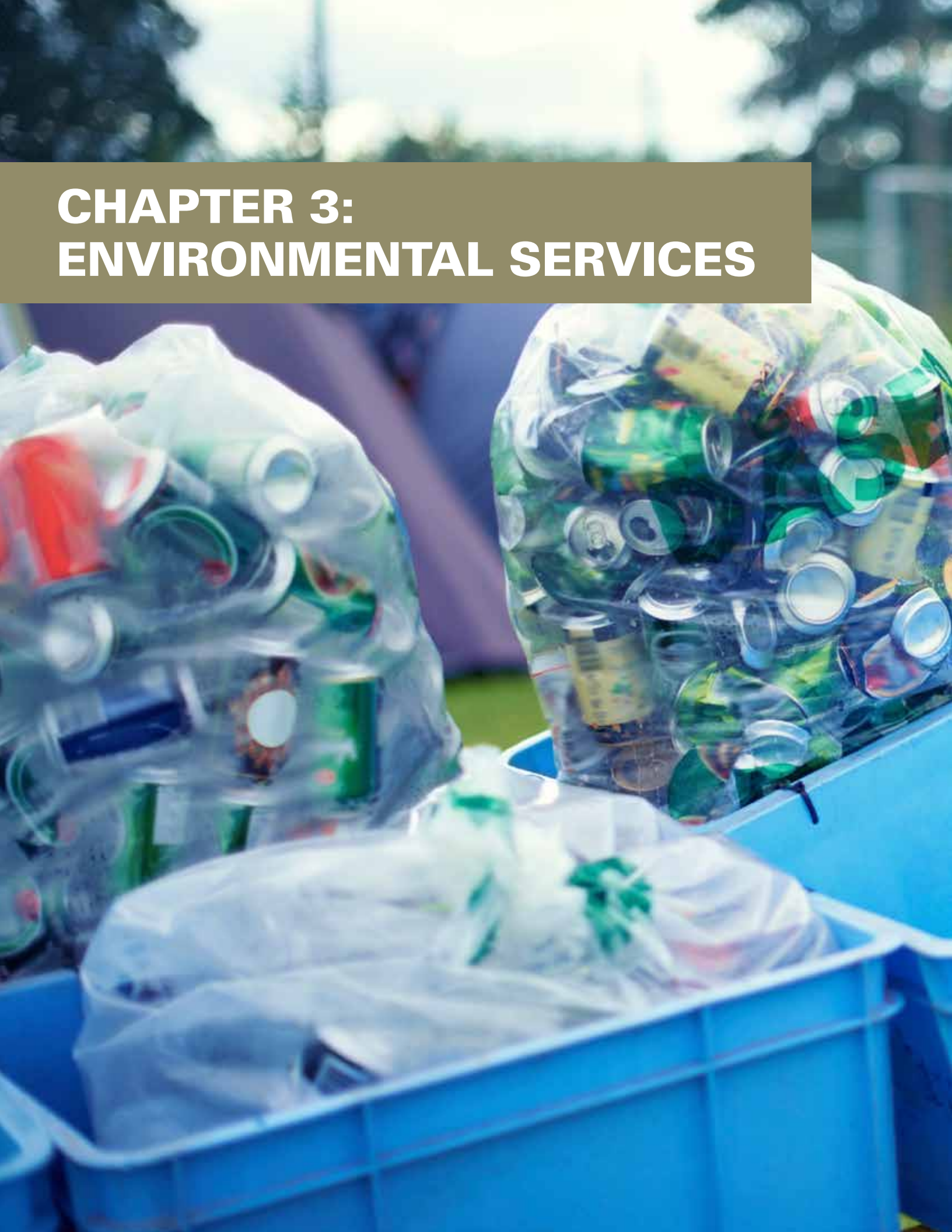
When assets cannot be (directly) reused, they are refurbished or remanufactured by GARS. Equipment is reconditioned, tested, and certified using rigorous processes and original manufacturing standards, or it is rebuilt to meet specific client requirements. This practice reduces the impact of products on the environment by extending the life of existing IT equipment and eliminating the need to manufacture new products.

Since 2002, IBM's GARS has:
- processed over 1.09 billion pounds of machines, parts and material,
- harvested and sold over 44.4 million parts, and
- processed and sold more than 3,900 rebuilt mainframes.

Only after all refurbishment and reuse opportunities are exhausted will the remaining fractions be sent for certified recycling and recovery operations. These operations help IBM win back valuable materials that can be used again for the production of new parts and components.

Summary
IBM has strong in-house capabilities and long-standing experience in implementing the elements of a circular economy. We apply these capabilities in support of our own business and our clients. We have shared our results through the publication of our annual *IBM and the Environment* report, which we have published for 25 years without interruption. Over the years, IBM has demonstrated that resource efficiency and pollution prevention make good environmental and business sense.

CHAPTER 3: ENVIRONMENTAL SERVICES



Reimagine Phoenix, the Resource Innovation and Solutions Network, and the Resource Innovation Campus: A Collaboration Platform for the Circular Economy

By John Trujillo, Director, Public Works, the City of Phoenix
With Dan O'Neill, General Manager, Walton Global Sustainability Solutions Services, Arizona State University

A transition from a linear economy to a circular economy requires a departure from the industrial status quo and the extensive engagement of corporate, cultural, and civic leaders. Additionally, research and development of new processing methods will be essential to transform waste into new products and resources. A successful transition to a circular model will enable vast amounts of innovation and collaboration across a variety of industries, both private and public, resulting in truly exciting developments.

The main driver of economic benefits in the circular model is derived from the ability to restore materials that would normally be disposed of in a linear production model. The restoration of these materials leads to multiple cycles of product use. The process of product reuse, repair, remanufacture, or recycle is more energy and cost efficient than producing from scratch.

Reimagine Phoenix was developed to create a cultural and behavioral shift among Phoenix residents and businesses in order to achieve the city's waste diversion goal of 40% by the year 2020. The campaign centers its main message on repositioning the concept of trash as a valuable resource rather than a material to be thrown away. Reimagine Phoenix deploys a comprehensive strategy to gain public buy-in and achieve measureable results through programmatic changes to existing solid waste programs, an inclusive communications plan designed to reach multiple target audiences, and partnerships with regional and private-sector organizations.

To accomplish this established goal, the city is working to invest in infrastructure for mixed waste and/or other solid waste diversion technologies. These will help to divert additional recoverable material in the municipal solid waste stream from the landfill, and create a circular system focused on job creation, new revenue for the city of Phoenix, and innovative development.

The city of Phoenix demonstrated its commitment and investment in innovation by establishing a partnership with Arizona State University's (ASU's) Walton Sustainability Solutions Initiatives as part of the city's Reimagine Phoenix initiative. Together, the city and ASU created the Resource Innovation and Solutions Network (RISN), intended as a global network of public and private partners who share the goal of creating economic value and driving a sustainable circular economy. RISN encompasses partnerships that cultivate cutting-edge research and

Master Plan for the Resource Innovation Campus

Site of the Resource Innovation Campus at the 27th Avenue Transfer Station, Materials Recovery Facility and Closed Landfill.

development opportunities to advance the diversion of waste and create economic value through the creation and advancement of new technologies.

To date, the city and ASU have developed 10 projects focused on waste aversion, diversion, and conversion solutions. Projects have focused on such areas as industrial recycling, multi-family recycling, waste aversion and education in school systems, zero waste planning and implementation for business, and food waste. The collaboration has engaged most of the more than 20 cities and two counties in the Phoenix area, the state, the Environmental Protection Agency (EPA), several nonprofits, and dozens from the private sector, from very large corporations to technology-based start-ups. One signature project is the development of a metro area–wide system design for managing green organics and food waste in a closed-loop manner; it is being funded by eight public entities.

The city and ASU are further fostering public and private partnerships through the development of the Resource Innovation Campus, located on a city-owned site that includes a closed landfill, transfer station, materials recovery facility, and more than 100 acres of vacant land. Through a "call for innovators" and a series of requests for proposals, the city seeks to populate the campus with interrelated business that will use the material resources available on the site.

RISN, which will be headquartered at the Resource Innovation Campus, will manage the on-site Circular Economy Technology Solutions Incubator space for innovators, developing emerging products and technologies from the city's waste resources. The vision of the Resource Innovation Campus is to be a world-leading, vibrant innovation hub, demonstrating the values of Reimagine Phoenix and the principles and benefits of the circular economy in action.

Together, Reimagine Phoenix, RISN, and the Resource Innovation form an enabling, collaborative platform to aid the Phoenix region in its transition to a sustainable materials management paradigm. With the city's support, ASU is working to expand RISN—and the idea of the Resource Innovation Campus—nationally and globally. To date, start-up RISN hubs are in Lagos, Nigeria, and Antigua, Guatemala. Several entities have expressed interest in creating similar initiatives across the United States. Other international collaborators are considering joining the network.

Ultimately, Phoenix and ASU hope to be catalysts in creating a global network of practitioners and academics working together to realize a more sustainable, circular future.

Recycling—Investing in the Future

By Jamie Bohan, Senior Director,
Recycling & Technology Development, Republic Services

Given the expected rates of population growth and the doubling of the middle class in just 15 years,[15] rethinking resource usage is becoming a business imperative. Decreasing a company's dependence on extracted or grown resources can help to mitigate price volatility, supply disruptions, and the costs of increasing regulations. One method for decreasing the usage of or extending the life of resources is through circular economy practices (Diagram 1).

As companies look to redesign their products for the inner loops of the circular economy ("product as a service" business models, reuse, or refurbishment), Republic Services recognizes the growing importance of recycling and minimizing valuable materials going to energy recovery or landfill ("leakage"). While the inner loops of the circular economy offer optimal savings in materials and emissions, recycling is an intelligent option for products whose economics do not justify creating new business or service models.

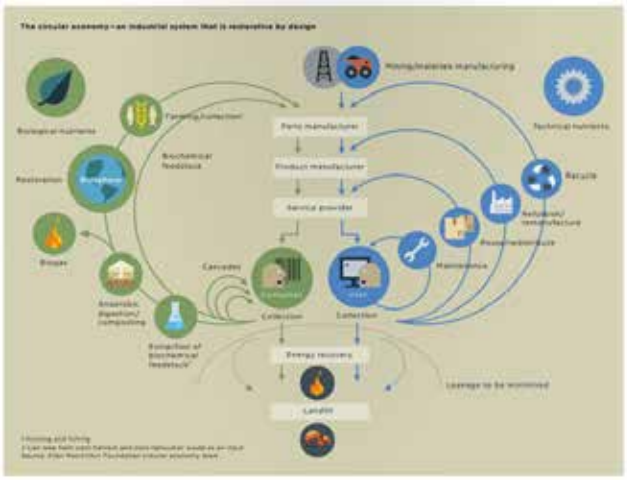


Diagram 1 – Circular Economy,
Source: Ellen MacArthur Foundation

15 OECD; middle class is projected to grow from 2 to 4.9 billion by 2030.

Although recycling has been around for decades, at Republic Services, we have been modernizing our infrastructure and capabilities to support and scale recycling across the United States. In keeping with our brand promise—"We'll handle it from here™"—our goal is to make it easier for companies to incorporate recycling into their sustainability programs. We accomplish this through expansion of access to recycling and the innovative use of technology. This is of growing importance today, as over 50% of waste generated in the United States is still sent to the landfill, and close to 80% of that landfilled material is recyclable.[16]

Access to Recycling

Recycling results in a significant reduction in greenhouse gases, compared to growing or mining those same commodities for use as virgin raw materials. Republic's goal is to increase society's ability to recycle, by adding capacity each year to our recycling infrastructure. Communities and businesses can add or increase recycling only when the infrastructure exists. Our goal is to add an additional 150,000 tons or more per year of recycling capability by 2018 to enable growth of recycling. This will result in a reduction of 480,000 tons a year of carbon dioxide equivalent (CO_2e)[17] for a total of 2.4 million tons of CO_2e reductions over the next five years. That's in addition to the 15 million tons

16 http://www.epa.gov/wastes/nonhaz/municipal/pubs/2013_advncng_smm_fs.pdf

17 EPA Warm Version 13, 6/14, Mixed recyclables; includes lifecycle assessment (LCA) of materials. Every ton of material that is recycled instead of landfilled results in a reduction of 3.2 tons of CO_2e.

of CO2e that we already avoid through previous recycling investments. In markets where we don't have recycling infrastructure, we've developed partnerships and alliances to ensure that our customers have access to recycling.

Innovative Use of Technology

Another key aspect of increased recycling is making it easier for customers to recycle. Republic's industry-leading All-in-One Recycling™ program accepts all recyclables in one container at work or at home, and our advanced sorting equipment ensures that recyclables are processed responsibly and reliably. We equip our recycling centers with the latest advanced technologies to detect and separate the different recyclables from one combined stream. Highly automated systems enable facility operators to continually monitor the sorting process, moving up to 110 tons of recyclables per hour and automating the baling and storage of finished commodities. For example, optical sensors can detect and separate plastics into as many as eight different types. In addition, we are testing and piloting technologies to leverage the value in materials that are suited for biological cycle, such as food and yard waste, and contaminated fiber.

Challenges

While these efforts are advancing our goals, we are the first to acknowledge that there is still much to be done. Recycling requires cultural and behavioral changes, and it is an ongoing endeavor. New employees require training in the mechanics, purpose, and benefits of recycling. Managers must continually analyze their company's waste stream to identify opportunities for recycling improvements.

At Republic, we help customers analyze their diversion rates, and we work with customers to design and implement education programs that incorporate recycling into employee workflows. We recognize the responsibility we have in managing the nation's waste stream, and we see the opportunity to provide renewable materials for our economy. Through our Blue Planet™ sustainability initiative, we embrace innovation, and we are constantly exploring new ways to capture value from materials in the waste stream, while ensuring environmental responsibility and sustainability. We believe in circular economy practices and their potential for increasing recycling participation and preserving precious resources.

Circular Economy in the Oil and Gas Refining Sector

By Edwin Pinero, Senior Vice President, Sustainability, Veolia

There's a deeply held belief and understanding at Veolia that we need to help facilitate the transition to a circular economy. To that end, we have been building our business and our brand around the idea of Resourcing the World to help develop behaviors that enable a new approach to resource management, which is a critical part of this new model.

One aspect of this approach is that we help overcome the dilemma between rising resource depletion and growing needs by giving value back to things that have lost their value. Our aim is to develop sustainable access to resources while also helping replenish and protect them. That can be done by adopting a circular economy approach. To best understand this concept in the context of what Veolia does, let us first "zero in" on water, the carrier of materials and energy. Water enables industrial processes, energy generation, and recovery. It enables economic growth, and it enables life. We also recognize that too little or too much of it can threaten those critical processes. As the world's leading and largest provider of water services and technologies, we believe that we have an obligation to find sustainable solutions around water.

Second, when we talk about nutrients and materials in the circular economy, there are both technical, such as synthetic chemicals and other manufactured non-biodegradable items, those that must be treated or disposed after use, and those which are biologic, that naturally reenter the ecosystem through natural degradation and reuse. Clearly, a goal of the circular economy is to promote more use of biologic nutrients. However, the reality of the economy is that technical materials play a key role in some sectors. From this perspective, the circular economy also extends to the refining industry. The refining sector introduces a great opportunity to apply circular economy principles that address both the water and technical materials aspects.

Almost half of all gasoline made at U.S. oil refineries uses a hydrofluoric acid (HF) catalyst in the process of refining hydrocarbons and producing gasoline. Small amounts of this acid must be neutralized with a base chemical, often potassium hydroxide (KOH). The resulting material, spent KOH, contained in aqueous mix, forming a wastewater, was disposed of by the refineries as a hazardous waste.

Veolia has developed a method to recover and recycle this spent chemical. Veolia operates two merchant facilities in the Gulf Coast region, taking spent KOH as a feedstock from the refineries. We process the waste stream such that we now recover the KOH for reuse. These KOH recovery services help keep client facilities operational. For every 100 pounds of KOH used, we recover and return nearly 95 pounds to each of our clients, who can then reuse the material in their refinery processes.

In addition to being able to reuse recovered material, we are avoiding the impacts of getting new KOH. These benefits are economic—for one client, a savings of over $20 million over five years. But the benefits are also environmental. In a recent year, we reduced the need for the quantity of virgin KOH to be produced, thus reducing corresponding greenhouse gas emissions by a carbon dioxide equivalent amount of over 40,000 tons per year. Similarly, approximately

13 million fewer gallons of freshwater were used as a result of the KOH recovery, compared with making new KOH. This is enough water to supply a family of four for nearly 90 years! No hazardous waste is generated in the KOH recovery process, and the little sludge that does remain is nonhazardous. The water effluent is also clean enough for reuse or safe discharge. Finally, 34% less energy is used to recover KOH than to manufacture virgin KOH.

Veolia's KOH recovery process demonstrates that circular economy principles do work, and they can be applied even in industries where, at first, it may seem impractical. There are many different examples and aspects of the circular economy at work in the oil and gas markets, particularly with recovery and reuse of used oil, but this process demonstrates that holistic approaches to dealing with waste streams have multiple economic and environmental benefits.

Designing for a Circular Economy: Returning Resources to the Value Chain

By Tom Carpenter, Executive Director, Sustainability Services, Waste Management

As companies compete for scarcer natural resources and sustainability leadership, the gap between product design and product recyclability grows. Waste Management's Design with Intent process seeks to close that gap by bringing end-of-use considerations to the forefront of product and packaging design.

Design with Intent is a research and assessment process that leverages Waste Management's expertise in recycling innovation, technology, and material science in order to help sustainability-minded companies incorporate recyclability and recoverability in every step of product design.

As North America's largest recycler, Waste Management is in a unique position to provide designers, engineers, and manufacturers with early-stage insights on how products and packaging behave in the real-world recycling infrastructure. Currently, many product initiatives focus on embedded energy reductions, often at the expense of end-of-use considerations. The result? More materials heading to landfills instead of being returned to the value chain.

Design with Intent helps companies identify product attributes that pose challenges to recycling, composting, and reuse. These range from materials selection and configuration to ease of disassembly—even product shape, size, and color choices are carefully scrutinized.

For products or packaging incompatible with the traditional recycling infrastructure, the Design with Intent process offers alternative recycling models, such as take-back and mail-back programs, and explores the financial impact of implementing technology that may lead to new reuse, recycling, or upcycling outlets.

Transparency is a key consideration when making claims about a product's green attributes. In addition to helping manufacturers create products that safeguard the greater environment, Design with Intent provides the research and assessment protocols necessary to help companies verify their product's environmental claims and to mitigate financial penalties from the U.S. Securities and Exchange Commission (SEC) and lawsuits from consumer watch groups.

Evolving from a research-only pilot program, Design with Intent has broadened its mission to address more complex second-use product design challenges, including lifecycle analysis that allows customers to make informed choices that minimize negative impact on the environment and human health.

What is the broader economic and environmental impact of the Design with Intent process? When end-of-use considerations are incorporated at the onset of product design, fewer materials end up in landfills, more materials return to the value chain, and markets for recycled materials are strengthened.

Most important, when products and packaging are designed with positive environmental intent, we create a new improved product—a healthy planet with natural resources meant to enjoy, instead of destroy.

CHAPTER 4: FINANCE

Enabling Conditions—Financing and Influence

By Bridget Croke, Director, Partnerships and Communications,
The Closed Loop Fund

In order for the circular economy to develop, recycling will have to play a central role. Recycling will provide the material that the circular economy will use. The good news is that recycling has the potential to drive billions of dollars of value via landfill disposal avoidance and revenue earned from the sales of materials. Unfortunately, many municipalities and recycling companies don't have access to the capital required to invest in the modern infrastructure needed to increase recycling rates. In 2013 alone, low recycling rates caused cities to collectively spend over $5 billion on landfill costs and to lose over $11 billion in commodity revenue from the potential sale of recyclable material that was sent to landfills. Additionally, the recycling system needs investment to ensure that it evolves to meet the needs of the changing packaging stream. In order to flip these losses to savings and unlock the financial value of the circular economy, we need to invest in the infrastructure required to collect, separate, and process these items into new products.

Enter the Closed Loop Fund, a social impact investment fund that provides cities and recycling companies access to the capital needed to build comprehensive, replicable recycling programs and that demonstrates best in class, replicable recycling models.

The Closed Loop Fund was formed by the world's largest companies (3M, Coca-Cola, Colgate-Palmolive, Goldman Sachs, Johnson & Johnson Family of Consumer Companies, Keurig Green Mountain, PepsiCo, Pepsico Foundation, Procter & Gamble, Unilever, Walmart, and the Walmart Foundation) to invest in recycling infrastructure and demonstrate the market potential to help unlock long-term public and private investments across the United States to optimize our recycling system.

Additionally, many of the Closed Loop Fund investors are creating robust goals for ensuring their products are recyclable and incorporating post-consumer recycled content into their packaging. In addition to funding scalable recycling projects, the Closed Loop Fund is helping to build connections between our investors and the companies processing their packaging, to ensure that everyone in that loop is working toward the same solution.

Examples of types of scalable models the Close Loop Fund will invest in are:

- **Single-Stream Recycling Collection in Large, Under-Performing Cities (examples include Quad Cities, Iowa, and Portage County, Ohio):** Cities in the Midwest and in the southern states still suffer from low recycling rates. By proving that an optimized single-stream recycling program has strong participation and saves Midwestern and southern cities money from landfill fees, additional cities and states will feel confident in investing in recycling.

- **Plastic Recovery Facilities (PRFs) (example includes QRS-Canusa PRF, covering the East Coast):** Number 3 through Number 7 rigid plastics often end up in landfills, due to the expense of processing them and inconsistent markets. This business model is a breakthrough in plastic recycling, making it more economical for cities and MRFs to sell a wide range of plastics back into the market. This will ultimately save MRFs and cities money and drive revenues for MRFs, thereby extracting maximum value out of these plastics, bringing them back into utility and removing them from the landfill.

- **Glass Processing and Market Development (example includes Momentum Recycling):** While glass may technically be infinitely recyclable, it is costly to recycle and commands low value in the marketplace. Therefore, many cities are removing glass from their household recycling collection. By investing in new processing technology that will sell into markets like construction (glass cost can competitively replace fly ash, a by-product of coal), we increase the value of glass and make it profitable to separate and recycle it once again. This helps glass and overall recycling economics.

Without investment, a fully circular economy will never be realized. The Closed Loop Fund is unlocking capital sources that will fund an important part of this new economy. We hope to inspire new forms of investment throughout this movement.

Photo Credit: WFP/Alexis Masciarelli

Refurbishing Truck Tires and Recovering Renewable Raw Materials

By Richard Piechocki, Senior Business Developer, Sustainability, Rabobank Group
Stephanie Potter, Vice President, Business Development and Program Office, Rabobank North America Wholesale

As part of a company-wide effort to support clients in developing new, more sustainable, and cost-effective business lines, Rabobank invited nine companies to participate in an inaugural one-year Circular Economy (CE) Challenge. The program concluded in Fall 2015 with all nine participating companies "crossing the finish line" and nine innovative solutions to take to market.

One such participant is a Dutch automotive company focused on facing a particular challenge: recycling and processing a primary residual waste stream of truck and passenger car tires.

The company's main motive for recycling and upcycling tires and recovering high-quality recyclable raw materials was simple: the opportunities such recycling provides for strengthening competitive market position and increasing revenue.

The company carried out a company scan (circularity checkup) together with Rabobank and knowledge partners as part of the CE Challenge. The scan revealed that the individual activities the company performs in the area of recycling and processing truck tires could reinforce each other through supply chain management.

Building off of this insight, the company developed a strategy around "devulcanization"— the process of reversing the vulcanization that converts rubber into more durable materials. The company now registers the tire flows, retreads worn truck tires, and processes scrap tires into granules that are used for a range of purposes including artificial turf fields. The company also uses a pyrolysis process to recover black carbon from the tires. Black carbon can then be used as a raw material for ink, among other purposes. The company is building a new plant especially for this process, and Rabobank is funding part of this project through green financing.

The company is also building a plant to devulcanize tire granules, which too results in useable raw materials for the rubber industry and tire manufacturers. Achieving improved alignment of these activities in cooperation with customers and partners will create a closed loop that produces benefits for everyone involved, including greater supply security, lower costs, and high-quality reuse. The company sees forming an entirely closed loop with customers and partners as the next challenge.

Rabobank is pleased to have concluded its first CE Challenge with such strong results and looks forward to continuing the momentum of circular economy–inspired thinking in many other realms of its operations. For Rabobank, the value the CE Challenge represents is threefold. First, it provides greater insight into our clients' business challenges and opportunities, thus enabling us to develop products and services better suited to support them. Second, it offers an alternative avenue of engagement with our portfolio of companies while simultaneously allowing them an opportunity to engage with and benefit from each other in unique,

valuable, and sometimes unexpected ways. Third, it presents the opportunity for Rabobank to leverage our position to make significant societal contributions by supporting alternatives to the current linear "take, make, waste" model in partnership with the growing global ecosystem of companies and partners equally committed to the transition to a circular economy.

Rabobank Group is a global financial services leader providing wholesale and retail banking, leasing, real estate, and renewable energy project financing in 45 countries. Founded over a century ago, Rabobank is one of the largest banks in the world, with nearly $1 trillion in assets and operations in more than 40 countries. In the Americas, Rabobank is a premier bank to the food and agriculture industry, as well as a leading financier of solar, wind, bioenergy, and energy infrastructure projects, providing in-depth knowledge and expertise as well as full arranging, underwriting, and syndication capabilities.

CHAPTER 5: MANUFACTURING

Caterpillar's Remanufacturing Business Helps Make Sustainable Progress Possible

By Robert K. Paternoga, General Manager, Caterpillar Remanufacturing

Caterpillar's remanufacturing business began in 1973; it has now grown to be the industry leader, employing nearly 4,500 employees from 17 facilities globally in a business model that leverages technology and innovation to maximize component recovery.

Machinery and engine product types have lent themselves naturally to the particular loops of a circular economy framework, because they enjoy a longer history of remanufacturing. Complex, durable parts and components remanufactured by Caterpillar range from engines, turbines, gas compressors, locomotives, and railcars to hydraulics, drivetrains, turbochargers, and fuel systems. Caterpillar does not remanufacture the entire machine, but rather key parts and components for machine repair, offering a lower owning and operating cost for customers. Remanufacturing is an exchange business where a core, or end-of-service-life, component is exchanged for a remanufactured component. Through the remanufacturing process, the core is completely disassembled, down to its individual constituent parts, including every last piece of hardware, and inspected against engineering specifications for salvageability. Those components that are within remanufacturing guidelines are thoroughly cleaned. Then they undergo additive manufacturing processes to bring them back to original, if not better, engineering specifications and tolerances.

While the connection between the circular economy concept and restoring performance to end-of-service-life components seems simple enough, there are still many opportunities for improvement.

In the 2012 report *Towards the Circular Economy*,[18] the Ellen MacArthur Foundation highlighted some significant opportunities with regard to product design and remanufacturing processes and technology. Caterpillar is often viewed as a leader in remanufacturing processes and technology that enable greater value to be recovered during the remanufacturing process. By replacing products before they fail and remanufacturing them with a mixture of new parts and cores that have been returned to original engineering specifications, Caterpillar's remanufacturing business has seen steady profitable growth.

The circular economy framework emphasizes the importance of designing effective products and systems, and not just focusing solely on efficiency. Rather than just aiming to use less material, Caterpillar employs a design-for-remanufacturing process to ensure that new parts and components are able to be remanufactured for multiple service lives. All of Caterpillar's remanufactured parts and components are also held to the same strict engineering standards to ensure that performance and reliability meet the same as-when-new guideline. In addition, Caterpillar estimates that the bulk of their costs are associated with overhead and material, therefore higher core salvage rates are a profitable advantage.

"Caterpillar helps make sustainable progress possible. Designing products for one lifecycle may allow you to sell that first unit more easily and at a lower cost, but it doesn't help form a relationship

18 http://www.ellenmacarthurfoundation.org/business/reports/ce2012

with the customer in the long term and help him reduce his lifecycle owning and operating costs."—Bob Paternoga, Cat® Reman General Manager

Caterpillar has a number of examples of this in its product portfolio. One of the most well-known involves an engine block with a removable sleeve in the cylinder bore. When the component is recovered, this material can be removed and replaced to return the engine to as-new performance. Previous techniques for remanufacturing engine blocks have involved reboring the engine cylinder and using a larger piston, but this can be done only up to three times before the quality of the product is affected. Additive manufacturing is also another option in use—cylinder bores can be resprayed with metal to return them to as-new condition.

In order to remanufacture products before failure, real-time diagnostic capabilities of the key components in the field is critical. While historically this process has been maintained between the dealer and the customer, Caterpillar is now beginning to use digital technology to add a "Product Link" service to units in the field. Through this new innovation, the company is now able to monitor operating conditions in real time, allowing for closer and more detailed tracking capabilities of the assets. This adds tremendous value by lowering owning and operating costs while more accurately predicting service needs.

In terms of pricing, Caterpillar is able to offer customers significantly lower prices on remanufactured parts when compared with new parts. Because remanufacturing is an exchange business, an important part of the pricing structure is the core deposit. A core deposit is charged to the customer when he purchases the remanufactured product, and the deposit is refunded when the core is returned (as long as it meets core return criteria). The core deposit is generally the difference between the remanufactured part price and the new part price, thus incenting the customer to return the core and repair before failure. The high rate of core returns—94% in 2014—enables Caterpillar to salvage more parts from returned cores, driving down remanufacturing costs. True to the definition of remanufacturing, Caterpillar's remanufactured products meet original tolerances and specifications, and are tested to ensure that performance is the same as when new, if not better. All Caterpillar remanufactured products are sold with the same warranty afforded to new Caterpillar parts.

"Some companies may wash, repair, and paint, but true remanufacturing requires complete disassembly, inspection against engineering criteria, and additive manufacturing or replacement to ensure the original specifications are met, including the latest engineering changes relevant to the product. The form, fit, and function will equal the corresponding new part."—Bob Paternoga, Cat® Reman General Manager

Other than increasing recovery rates for cores, which is a continual opportunity for improvement, one of the key obstacles with the practice of remanufacturing globally is the ability to import and export cores and the ability to sell remanufactured components. Many developing countries do not fully understand the benefits of remanufacturing and have customs regimes that prohibit the ability to sell remanufactured parts. Caterpillar works with its dealers, customers, and government officials to reduce these trade barriers and ensure that all Caterpillar customers around the globe, regardless of their location, can realize the sustainability benefits of Caterpillar's remanufactured products.

Corporate Darwinism and the Circular Economy

By Hugh Welsh, President, DSM-North America

Charles Darwin famously stated that it's not the biggest or strongest that will survive, it's the most fit to face and evolve successfully to meet the challenges that lie ahead. This is as true in business as it is in nature, and the challenges facing business are profound. Companies that can use resources more efficiently will be more competitive in a word of increasing demand, declining resource availability, and rising costs. The world will require 70% more food and 50% more energy to meet anticipated demand by 2035. Such issues as climate change and environmental impact will require society to value natural capital—such as carbon, water, and air—at its true cost. Those companies that can evolve to meet these new challenges and opportunities will be those that survive and thrive. That evolutionary process in business is patterned on the transition from the linear to a more circular economy.

DSM, the global leader in life sciences and materials sciences, uses the concept of the circular economy as the prism through which we view commercial markets and set our strategy in each of our operating businesses. DSM believes that eliminating or repurposing waste systematically in the value chain creates competitive advantage and value for our customers and stakeholders.

DSM is working on multiple initiatives in the agricultural sector that apply circular economic principles to create value through eliminating the concept of waste. Corn is the most widely cultivated crop in the United States. It also produces the highest volume of waste, such as stalks, leaves, and cobs (stover), per acre. As corn yields continue to improve, more stover will be created—up to nine tons per acre. This increased stover can have negative impacts on agriculture, such as degradation of soil, increased disease, and adverse effects on groundwater. Today some of this stover is used as tillage; the remainder must be removed.

DSM, together with it partner POET, can turn this waste stover into energy. Through proprietary processes, enzymes, and yeasts, we can use corn stover as a feedstock, extracting its sugars; through fermentation, we can create cellulosic ethanol, a transportation fuel blended with gasoline, which can be used in nearly every vehicle on the America road today.

We can do this at scale as well. Last year DSM and POET opened Project Liberty, a commercial-scale producer of cellulosic ethanol in Emmetsburg, Iowa. When this plant is at full production, it will be able to convert corn stover into 25 million gallons of cellulosic ethanol annually; that's enough to replace more than 1 million barrels of crude oil. Cellulosic ethanol, created using waste as a feedstock, also results in a reduction of greenhouse gas emissions by 90%, compared with gasoline.

DSM has invested more than $200 million in developing and deploying this technology at Project Liberty, and we look forward to licensing the technology for the construction of future facilities worldwide. In addition to the environmental benefits, ethanol produced from waste stover, not corn, has economic benefits for the rural community and the nation. Farmers realize up to an additional $125 per acre increased profit as a consequence of cellulosic ethanol. This is realized through the sale of stover (waste) to DSM as well as through reduction in tillage costs, increased yields, and cost savings. Our nation

enjoys a home-grown transportation fuel, reducing dependence on foreign imports and improving our national security in terms of military deployment, energy security, and climate change mitigation. American consumers benefit by enjoying lower prices at the pump and more choice.

This transformative technology has proven scalable: repurposing a waste product to meet the energy needs of the American people and the economic needs of our rural communities. It is not without its challenges, however. The oil and gasoline industries have enjoyed a near complete monopoly on transportation fuels for more than 100 years. Their transition from a linear economy to a circular economy, from drilling and refining to growing and fermenting, will have to be facilitated by governments and consumers. Just as the Stone Age did not end because we ran out of stones, the age of fossil fuels will not end because we run out of oil. It will end with adoption of new cellulosic ethanol technology that creates domestically produced, cleaner fuel that uses waste as a feedstock, helping our farmers and reducing our dependence on those from whom we import oil. DSM can bring these benefits for all stakeholders—and do so profitably. This is the business case for the circular economy.

GM Helps Launch New Trash-to-Treasure Sharing Economy

By John Bradburn, Manager of Waste Reduction, General Motors

Many progressive businesses are operating with the mindset that waste is merely a resource out of place. And they often play a lot of connect-the-dots to give a by-product a second useful life.

But what if a company had more than just its own resources to channel this creativity? What if you could open up the possibilities with resources from other organizations willing to trade?

That's the premise behind the Reuse Opportunity Collaboratory Detroit (ROC Detroit). The initiative brings together Michigan institutions, businesses, and entrepreneurs to develop zero-waste partnerships in which one organization's waste becomes another's raw material.

GM partnered with Pure Michigan Business Connect, the Detroit Economic Growth Corporation, CXCatalysts, and the U.S. Business Council for Sustainable Development to transform the concept into a reality. Michigan Economic Development Corporation's CEO Michael A. Finney referred to ROC Detroit as a groundbreaking effort to support sustainable manufacturing while growing Michigan's economy and creating jobs.

Thinking of waste as a resource out of place has produced several reuse opportunities for GM, and it's been a philosophy that's helped us achieve an industry-leading 122 landfill-free facilities around the world. For example, used tires from our proving grounds are recycled to make air and water deflectors for the Chevrolet Volt, and plastic packaging from plants is mixed with other materials to make radiator shrouds for the Chevrolet Silverado. To help give life to more of these types of projects, we hosted the first ROC Detroit event at our global headquarters.

The event included a discovery session where participants discussed their top resource challenges, from chemicals to plastics and construction demolition materials. Then they shared ideas for collaboration.

Pashon Murray, founder of composting start-up Detroit Dirt, spoke about innovating for job and wealth creation. Seeing the growth of the urban farming movement in Detroit, she began pushing the idea of closed-loop systems. The relationships she built with the city and various businesses led not only to nutrient-rich compost that helps reduce environmental impact but also to bottom-line discoveries, like decreasing waste bills and creating efficiencies in kitchens as chefs received a better idea of what to order.

The room was full of entrepreneurs like Murray as well as automakers, suppliers, and NGOs. Even representatives from Detroit's maker and artist community attended.

Bethany Shorb networked with industrial companies and resource management partners to find parts and scrap for art. She's part of an organization called OmniCorp Detroit that pools tools and resources in one collective space.

She put it simply: "There's so many people out there who want your stuff."

By the end of the day, wheels were turning and connections were made.

Months of planning, involving a variety of stakeholders representing various interests within Michigan, paid off as the program launched. To GM, it is a pilot to see how we might implement it in other regions of the world that could benefit from a strong reuse network.

The initiative is representative not only of our vision for waste reduction but also of how communities and individuals from a variety of interests can be brought together to benefit the greater good. Not only does the collaboration benefit GM by providing more options for creative reuse and strengthening our network, it provides a boost to the economy as a whole. Start-ups make more contacts so they can build their businesses, businesses create partnerships with new companies, and socially minded organizations get introduced to new sources of material.

The environmental benefit is clear—keeping materials in their use phase and out of the ground. Energy costs also decrease, as reuse is even better than recycling. But in addition to the environmental benefit, economies are strengthened and more voices are heard.

From here, ROC Detroit has big plans. In addition to making connections in person and through matchmaking analysis, it hopes to create an online materials marketplace where organizations can post their materials and search for items.

It will continue to build its network by recruiting suppliers and users, collecting and analyzing data for synergies, and meeting to share, network, and generate opportunities.

Reduce, Reuse, Recycle. . . Remanufacture

By W. Scott Tew, Executive Director, Center for Energy Efficiency & Sustainability (CEES), Ingersoll Rand

Clean, comfortable indoor environments and safe, fresh food are essential to quality of life, with greater industrial productivity being key to economic prosperity. But in a world confronting accelerating growth in urban populations, increasingly volatile energy costs, and the impending threat of climate change, our approaches to meet these needs must be environmentally and socially sustainable.

To meet future demands on food, water, and energy, industry must learn to work with materials and products currently available to ensure that we are more productive with—and get more out of—today's available resources. Ingersoll Rand, in its continuous effort to advance the quality of life and make the world a better place to live, is a longtime advocate of remanufacturing industrial equipment, specifically compressors and CenTraVac chiller motors, to extend the functional lifespan and decrease the waste of its product portfolio. Trane, a brand of Ingersoll Rand, has been remanufacturing compressors for replacement in water and air cooled chillers and unitary and rooftop heating and cooling units, extending the life of its customers' products since 1973. The Trane Remanufacturing Center in Charlotte, North Carolina, remanufactures more than 13,500 compressors a year, including some compressors originally manufactured in the 1950s.

From end-to-end, recycling is top of mind, with the goal of rebuilding each compressor with as few new parts as possible. Following a detailed teardown, technicians carefully examine each piece of the compressor to determine parts eligible for reuse and parts eligible for recycling. A critical step is to carefully clean each and every part. The Charlotte Remanufacturing Center's cleaning process has been awarded the platinum award by the Charlotte Mecklenburg Utilities Department for exceeding compliance standards in all water-sampling discharge limits and reporting requirements for five consecutive years. Final pieces are fine-tuned and tested to ensure safe and efficient remanufactured compressors.

"We save about 130 tons of materials each month from being indiscriminately thrown out, and take great care to appropriately recycle each piece we're unable to put back in the compressor," said Marcy McClanahan, plant manager and Charlotte site leader. "Putting these machines back out into the world to run safely and efficiently for another 20 to 25 years without negatively impacting our environment is paramount to helping achieve our Climate Commitment and reduce the impact of our products."

The facility recycles an average of more than 130 tons of material each month and is well on its way to becoming one of Ingersoll Rand's most environmentally friendly manufacturing centers.

Materials	Amount Recycled
Aluminum	7.2 tons per month
Copper	13.3 tons per month
Steel	90 tons per month
Plastics	300 pounds per month
Wood	11 tons per month
Cardboard	8 tons per month
Mixed recycling	1 ton per month
E-waste	1,364 pounds in 2014


5611
5568

Novelis Leverages Aluminum's Unique Properties to Meet the Needs of Customers and Reduce Carbon Emissions

By Jessica Sanderson, Director of Sustainability, Novelis

As the world's largest recycler of aluminum and producer of aluminum flat rolled products (FRP), Novelis is leveraging aluminum's unique properties to meet the needs of our customers, while also providing them with solutions to reduce the risks associated with growing global carbon constraints.

Global demand for aluminum FRP continues to increase, driven by long-term economic growth in emerging markets as well as by sustainability drivers, such as climate change, rising energy demands, and natural resource scarcity. The inherent properties of aluminum—strong, malleable, conductive, lightweight, and infinitely recyclable—mean that substituting aluminum for other materials has the potential to meet demanding performance requirements while also reducing energy use and greenhouse gas (GHG) emissions. The environmental benefits are all the more pronounced when recycled aluminum is used, since recycling aluminum requires just 5% of the energy—and generates just 5% of the associated GHG emissions—compared with producing primary aluminum. As a result, manufacturers are increasing their use of aluminum in a broad range of products.

The fastest-growing market is the automotive industry, where car manufacturers are significantly increasing their use of aluminum as a means of light-weighting vehicles. Reducing vehicle weight is a key enabler for achieving the emissions reductions and fuel-efficiency improvements that consumers are demanding and governments around the world are mandating.

In the past few years, Novelis has significantly increased our production capacity to meet growing demand, while at the same time we have nearly doubled our recycling capacity, increasing our ability to recycle aluminum. Since 2011, Novelis has made approximately $2 billion of capital investments in strategic locations to position the company to meet the growing demand for premium aluminum FRP.

Novelis has made solid progress, firmly establishing our company as the leading recycler of aluminum in the world and increasing our recycled inputs to 49% in 2015, up from 33% in 2011. By the last quarter of our 2015 fiscal year, we were operating at a run rate of 53% recycled content. We are very proud of what we have achieved so far. We recognize, however, that we cannot achieve the vision for a more circular economy on our own; rather, it will require collaboration among a broad range of stakeholders and partners—from our customers, brand holders, and others in our industry to nongovernmental organizations, policymakers, and more. Truly closing the loop requires working to shape and shift policies, practices, and behaviors that are outside our direct sphere of control—particularly those related to post-consumer recycling, scrap collection infrastructure, consumer product design, and recycling and climate policies.

Achieving our strategy also requires collaboration within our industry. A central tenet of this approach is recognition that making products that are recyclable is not sufficient on its own and that it is equally important to work actively to ensure that those products are actually recycled and then used in products that continue the cycle.

We believe the business case for the circular model is clear, led by significantly improved supply-chain efficiency and continuity. The new model means

that we are less reliant on carbon-intensive primary aluminum. By collecting aluminum scrap and recycling it into sheet ingot for use in our own operations, we are better able to manage and anticipate costs, and to make reliable projections about incoming metal shipments. In short, we are increasingly more in control of our supply chain.

The long-term trends driving demand for aluminum FRP are firmly established, and the investments we have made are positioning Novelis to meet and capitalize on that demand. We remain confident that our strategy is sound and that it serves as a valuable competitive advantage for our company.

Steelcase Brings the Circular Economy to the Furniture Industry

By Angela Nahikian, Director of Global Sustainability, Steelcase Inc.

In the United States alone, it is estimated that 3 million tons of commercial furniture is landfilled each year. It is a staggering amount in an industry where products are built to last for decades and often become outdated before the end of their useful life. In many cases, disposed furniture could be recycled, resold, repurposed, or donated. But it isn't transitioned into a new lifecycle because the predominant "take, make, waste" linear business model isn't designed for reuse or reclamation.

As the global leader in the furniture industry, Steelcase has led the way in closed-loop product design thinking. For nearly a decade, we have held the most Cradle to Cradle Certified™ product certificates worldwide. Concurrent to designing products in this way, we have been fostering partnerships and creating services in an effort to pave a path to a circular business model.

Products Designed for Circularity

Steelcase launched the Think® chair in 2004. It was iconic: the world's first Cradle to Cradle Certified™ product designed for the circular economy. By 2012, we were inspired to rethink Think; in the process, we delivered greater innovation, created more value through fewer parts, enhanced durability, and improved ergonomics.

The outcome: an intelligent chair designed for extended use and material reclamation. It is up to 95% recyclable, made from meticulously selected materials that promote human and environmental health, and is easily disassembled with common hand tools. It is a great example of the company's design philosophy in action and one example of the extensive number of like products Steelcase offers.

Partnerships to Advance Innovation

In November 2011, Steelcase collaborated with Designtex, Victor Group, and Unifi to brainstorm a system to capture and recycle textile waste. Together, the four companies have established a process to collect and sort fabric waste at the Steelcase Athens, Alabama, manufacturing facility. This waste is sent to Unifi and remade into fiber and yarn. Then, the yarn is sent to Victor Group to be woven into new textiles for both Steelcase and Designtex.

This partnership has resulted in the creation of three upholstery fabrics: Loop to Loop, which was introduced in 2013, and Hyphen, Redeem and Retrieve, which launched in 2014. This effort is inspiring new product offerings and new collaborations.

Steelcase is working with other Circular Economy 100 (CE100) companies from the built environment and retail sectors to explore how we might create new industrial systems to collect and reutilize textiles at scale.

Services Built to Enable a Circular Economy
Steelcase's innovative reuse and recycling programs—Phase 2 and ReMarket™ in North America and Eco'Services in France, Switzerland, Belgium, and Luxembourg—are redefining waste streams for our customers by providing alternatives to landfills. We created these programs to assist businesses with the collection and redeployment of furniture and building assets. Consultants from these programs help manage a company's inventory, create a solution to bring the most value to customers by optimizing the potential for resale, charitable donation, and recycling of each of their assets.

Last year, we added the Gesture® Trade Up program. The pilot concept was simple: businesses or individuals could trade in their used chairs of various makes and models for credit toward new Gesture chairs. Thousands of chairs were either recycled or carefully refurbished with new materials and parts to optimize their second-life value.

The Phase 2 and ReMarket™ programs have diverted over 50 million pounds of furniture from the landfill. In its seven years, Eco'Services has resold, recycled, and donated 33,200 workstations. Organizations in 51 countries have received furnishings as a result of our end-of-use programs.

Exploring Alternatives Business Models
Designed as an alternative to traditional workspace, Workspring® by Steelcase builds on the idea of collaborative consumption and allowing businesses and people access instead of ownership. Workspring

offers individuals and teams a variety of highly customizable spaces and services designed to promote wellbeing and help people do their best work, however they work. It offers companies the ability to support shifting workstyles and mobile workforce in ways that can positively impact business. Having refined this model over a number of years, we're exploring opportunities to partner with hospitality organizations and others to scale it.

These are a few examples of what Steelcase is doing and preview what is possible in a circular economy. There are dramatic opportunities for innovation and growth in the 21st century. At Steelcase, we know firsthand that disruptive innovation is complex and challenging; moving forward means leaving past solutions and "business as usual" behind. By decoupling ourselves from the current linear economic framework, we might realize positive change at a scale and speed rarely experienced before.

Rethinking Our Business Models, Products, and Factories to Become a Truly Sustainable Company

By Marty Neese, Chief Operating Officer, SunPower Corporation

One of the tenets of the circular economy is that systems should be powered by renewable energy, which include wind, solar, and geothermal sources. According to roadmaps published by the International Energy Agency (IEA), solar photovoltaic has the potential to become the world's largest source of electricity by the year 2050.[19] By integrating circularity thinking into its product design, manufacturing processes, and business models, SunPower wants to be a key contributor to this new industrial system.

Designing for Durability and Recyclability

Durability and reliability are essential customer requirements. SunPower has expanded its modules' lifespan through fundamental design changes, including the use of n-type silicon and a tin-coated copper foundation, which provide protection against real-world physical and environmental stresses, such as thermal cycling and repeated snow and wind loading. By designing for durability, SunPower's panels have an expected useful life of more than 40 years (defined as 99% of modules producing at least 70% of their power), and they illustrate how we can move away from the concept of a "disposable" product. While the ultimate goal is to design out as much material waste as possible, products will still reach an end to their useful life or will undergo replacement by the customer. Ideally, products can be disassembled so that components can be reused, refurbished, or recycled into higher-value products (often referred to as upcycling). For SunPower modules, a Reuse and Recycle Program has been created to allow functional products to be reused at SunPower facilities or recycled at certified facilities. Efforts continue to identify more circular practices, including using recycled content material and upcycling waste material into higher-value products.

Cradle-to-Cradle Certification

Cradle-to-Cradle (C2C) product certification provides a framework to help companies: (a) develop a comprehensive corporate sustainability strategy and (b) ensure that customers gain the most economic, environmental, and social value from their products. One tangible way this sustainability benefit is shared with our customers: C2C certified products are eligible for additional points under the latest version of the U.S. Green Building Council's LEED green building rating program.

The five categories of C2C certification are: Material Health, Material Reutilization, Water Stewardship, Carbon Management and Renewable Energy, and Social Fairness. To meet these requirements, SunPower collaborates with suppliers to ensure that the materials and services (e.g., recycling) supplied meet regulatory and sustainability requirements. In addition, SunPower sets goals related to resource consumption, which encourage our teams to integrate circular considerations and systems thinking into manufacturing processes and building facilities. C2C certification provides not only a scorecard by which progress to our sustainability goals can be tracked but also a roadmap for future innovation in our products, operations, and supply chain. The results have enabled us to undertake two additional certifications for our factories: Landfill-Free and LEED. Taken together, these certifications validate our comprehensive sustainability strategy in which we think systematically and work toward the goal of not just minimizing harm ("less

19 http://www.iea.org/newsroomandevents/pressreleases/2014/september/how-solar-energy-could-be-the-largest-source-of-electricity-by-mid-century.html

bad") but maximizing value and benefit ("more good") to customers, employees, and communities.

Alternative Business Models

Innovative business models that offer solar-generated electricity as a service are becoming increasingly popular. Two forms of these business models are the Power Purchase Agreement (PPA) and the Yieldco. In a PPA financial agreement, a developer provides the design, permitting, financing, installation, operations, and maintenance of a solar energy system on a customer's property—at little or no cost to the customer. Very similar to a PPA is a solar lease in which the host customer receives the benefits of solar with little or no upfront costs. Another mechanism for financing renewable energy projects is through a yieldco. A yieldco is a publicly traded company that bundles long-term contracted operating assets in order to generate predictable cash flows. This investment can be attractive to shareholders because they can expect low-risk returns that are projected to increase over time. Yieldco investors typically receive 3%–5% returns and long-term dividend growth targets of 8%–15%. These alternative business models provide new sources of capital for developing on-site and commercial renewable energy projects. They also provide another opportunity for companies, such as SunPower, to retain and monitor assets to facilitate the tracking, repair, refurbishment, upgrade, or upcycling of materials.

Water Reuse: A Critical Component of a Water-Secure Future

By Abigail Antolovich, N. A. Reuse Business Development Manager, Xylem Inc.

As the global population continues to grow, access to scarce resources, particularly water, will become more strained. By some estimates, global demand for water will exceed supply by 40% by 2030. At the center of this challenge is an adherence to a linear model of managing water and wastewater that facilitates waste and inefficiency at every step of the process. We must transition from this unsustainable model to one in which water is part of a circular economy that uses and reuses resources intelligently.

As a leading water technology company, Xylem is working with customers and partners around the world to develop innovative solutions to these water challenges. Water recycling and reuse is one proven solution that can help to meet our growing water demands while safeguarding our existing water supplies.

Water recycling is the reuse of treated wastewater for beneficial purposes, such as agricultural and landscape irrigation, industrial processes, or replenishing a groundwater basin. Wastewater can be treated—or, more simply put, cleaned—to meet the most stringent water quality standards. Importantly, this resilient and drought-proof water source can often be achieved at a lower lifecycle cost than that of developing a new water supply option, and it delivers environmental co-benefits.

California: "The New Normal"

As California, the nation's most populous state, once again faced severe drought conditions, communities began to accelerate their plans to identify both short-term fixes and sustainable solutions to what many referred to as "the new normal" conditions.

In San Jose, the Santa Clara Valley Water District (SCVWD) faced diminished rainfall, a depleted aquifer basin, and near-empty recharge ponds as it searched for new water supplies to maintain economic vitality for the growing Silicon Valley community and economy, which is a driver for the state's economic health. The SCVWD Board of Directors determined that water reuse for nonpotable as well as potable purposes would be critical to establishing a drought-proof water supply for the region.

The SCVWD built the 8 million gallon per day (mgd) Silicon Valley Advanced Water Purification Center (SVAWPC), the first of its kind in northern California. This state-of-the-art facility was designed to expand nonpotable water supplies for irrigation and industrial uses, and to reduce the region's dependency on imported water. At the SVAWPC, treated wastewater is further cleaned through a multi-barrier treatment process that includes microfiltration, reverse osmosis filtration, and ultraviolet (UV) disinfection.

Solution
In designing the facility, engineering firm Black & Veatch focused on technology that would treat the water to California's most stringent unrestricted water reuse standards. A component to the high-quality water output at the SVAWPC is the final step in the treatment process: Xylem's unique UV disinfection system.

Xylem's Wedeco LBX Series is a closed-vessel UV disinfection system designed for energy-efficient disinfection of wastewater, water reuse, surface water, and process water. With more than 1,000 installations worldwide, Xylem's LBX UV systems have been tested extensively to meet the U.S. Environmental Protection Agency's UV Disinfection Guidance Manual and the National Water Research Institute's UV Disinfection Guidelines for Water Reuse, including complying with California's stringent Title 22 unrestricted water reuse standards for disinfection.

Result
The new system, commissioned in 2014, disinfects potentially harmful pathogens and produces purified water, using a patented dosing control method to monitor operating conditions. Operation of the entire system is automatic, with minimal input from operators.

The purified reuse water is blended with conventionally treated recycled water from the San Jose-Santa Clara Regional Wastewater Facility, which produces recycled water with average total dissolved solids (TDS) of 700–950 parts per million. By blending the water produced from each facility, TDS levels are reduced to an average of 500–550 parts per million—a higher-quality water preferred by many industrial and irrigation customers.

Xylem is dedicated to solving the most complex water challenges, and we believe that water reuse is an essential contributor to a water-secure future. To that end, we continue to partner with institutions around the globe to advance research and innovation in water reuse. We also remain committed to increasing public awareness and understanding of these global water challenges so we can all move toward more sustainable practices.

CHAPTER 6: PLASTICS AND PACKAGING

Reimagining Packaging and Waste: New Approaches to a Circular Economy

By Dr. Ronald Cotterman, Vice President, Corporate Sustainability, Sealed Air Corporation

Packaging is often a focus in circular economy discussions. While packaging enables the protection and distribution of goods across increasingly complex supply chains, it can also become a source of waste. Addressing this waste is directly connected to the now famous reduce-reuse-recycle strategy for minimizing the amount of packaging, reusing it where possible, and recycling what remains—often into new packaging.

While the reduce-reuse-recycle approach has led to important gains that have reduced our dependence on resources, there is still room to improve. Companies are looking for ways to reduce and optimize packaging amounts; municipalities are considering ways to expand the range of materials they collect, sort, and recycle; and the entire supply chain is looking to new recycled material streams to compete with virgin materials. According to the U.S. Environmental Protection Agency (EPA), only 51.5% of containers and packaging materials were recovered in 2013. For this reason, there is a need for companies—working within their supply chains and with a range of other stakeholders—to "reimagine" packaging and waste. By reimagining, we create additional opportunities for the circular economy in new and intriguing ways.

Reimagine: Waste as Packaging

Today, packaging materials are manufactured from commodities such as fiber, glass, metal, and petroleum products. Recycled materials are used to supplement virgin material sources, and new bio-based plastics materials are being developed from agricultural sources. However, what about considering alternative materials that are waste today? For example, consider agricultural by-products, such as rice hulls, corn stover, or walnut shells. Could they be the packaging of tomorrow? An example of this approach is Sealed Air's Restore® mushroom packaging. Restore is grown by using mycelium to bind agricultural waste into a strong, all-natural composite that offers high-performance cushioning. The resulting product is also compostable after use.

Reimagine: Packaging to Prevent Waste

As we increase our awareness about the amount of products that are wasted through damage or spoilage, we are reminded that much of this waste might be prevented through properly designed packaging. As a result, packaging is often a solution to waste, rather than a source of waste. Consider fresh food. The spoilage of many perishable foods can be slowed or retarded by packaging. Use of modified atmosphere packaging extends freshness—without the use of preservatives—of products such as produce, bakery, and processed meats. Completely removing the air around food to create a vacuum, such as Sealed Air's Darfresh® vacuum skin packaging, allows products such as fresh red meats to last for weeks instead of days. Extending food freshness helps the supply chain;

it also helps consumers to reduce the amount of food that spoils before they can enjoy it.

Reimagine: Waste Packaging for Social Good

Waste plastic packaging can be used to deliver societal benefits in areas where recycling is not a viable option.

First, waste plastics represent an alternate energy source, particularly in countries that must import petroleum products. In these areas, collecting and converting waste plastics into transportation fuels can become a reality with the advent of new plastics-to-fuel technology. The focus is on achieving cost-effective scale to create products that can become sources of fuel for heating, cooking, and transportation. Through groups such as the American Chemistry Council, Sealed Air is helping to advance technology developments.

Second, waste plastics can be used to make goods that meet critical societal needs. For example, Sealed Air is pioneering work to convert waste packaging materials into goods that are needed to support communities. Examples include foot-operated pumps used to move water in remote villages in Southeast Asia, waste that has been fabricated into desks for schoolchildren in Africa, and even waste that has been converted to plastic sheeting used to help families rebuild their lives and homes following natural disasters or fire.

These examples illustrate what is possible when we reimagine packaging and waste. While reducing, reusing, and recycling remain important parts of a materials management approach, thinking about waste in new and different ways opens up new avenues of possibility in the circular economy.

Driving Business Value from Renewability and Sustainable Sourcing

By Elisabeth Comere, Director of Environment and Government Relations, Tetra Pak

At Tetra Pak, the world's leading food processing and packaging solutions company, everything we do is driven by a simple promise: to protect what's good. That commitment also relates to minimizing our impact on the environment. As a result, bringing environmental innovation to the market while reducing our dependency on finite resources is core.

For us, the restorative principles of the circular economy govern not just our commitments but also actionable, day-to-day operations of our company. The results and outcomes have been significant, especially in the context of responsible sourcing and use of renewable materials at the beginning of a package's lifecycle, which we believe is fundamental to achieving a genuine circular economy.

As we develop and deploy best practices around sourcing and use of raw materials, in addition to our ambition to develop a 100% renewable package, we are making strides in increasing the use of certified paperboard and bio-based polymers, and advocating for global standards that will prompt new industry-wide practices. For example, in 2014, 43% of our supply was FSC certified, and customers in more than 50 countries used the FSC label. In the United States, 100% of our paperboard met FSC Controlled Wood requirements, ensuring that we meet global forest management criteria around harvesting that is not in violation of human rights or an infringement of high-value conservation.

Through an approach rooted in renewability, we are also employing circular economy principles to capture value of resources on the front end, or at the beginning of the lifecycle. As we define it, renewability is about using a resource that can be regrown or replenished naturally with the passage of time; paperboard-based packaging and renewable polymers, such as bio-based polyethylene, are two examples.

Certainly, circular economy principles aimed at eradicating waste are important. In fact, over the years, we have been focusing a lot of our resources and efforts at increasing recycling across the United States. And we have seen huge gains in this regard, expanding household access to carton recycling at over 55% throughout 10,500 communities in 48 states. But waste management and optimizing at the end of life for the regeneration and reuse of materials alone is not enough. The reality is that the recycling infrastructure in the United States is complex, both in the short term for materials recovery, and over the long term, around challenges like new material innovation. This makes it difficult if not impossible to rely only on recycled feedstock to replace virgin materials.

For our part, innovative use and deployment of renewable materials and a focus on the front end of the lifecycle are key. We were the first to bring bio-based caps to market, launching in Brazil in 2011. Also in Brazil, we pioneered use of bio-based plastic layers made from sugarcane. Today, 13 billion Tetra Pak carton packages there are made from responsibly sourced paper- and sugarcane-based plastic.

Advantages

We and others are realizing that innovation in the development and use of renewable materials yields both economic and environmental advantages. Responsible sourcing and increased use of renewable materials can ensure a more predictable, secure raw

materials supply that is less affected by geopolitical factors. This leads to a more reliable supply chain, an improved ability to manage costs, and less price volatility. We're also seeing changes in consumer behaviors, motivated by concerns about resource scarcity. Capitalizing on this sentiment builds brand equity and purchasing loyalty among consumers.

Use of renewable materials is also linked to keeping the climate in balance. For example, along with more efficient use of energy, this approach can help reduce reliance on fossil fuels and ultimately improve the carbon intensity of the product throughout its lifecycle. As our analysis shows, using renewable materials in packaging can provide a step change for positive results: if 75% of a package's weight is from renewable paperboard, then that element of the package contributes only 20% of the carbon impact throughout the package lifecycle.

The Way Forward

Easy access to renewable materials and mainstream adoption of responsible sourcing practices is increasingly becoming part of the circular economy conversation. But more must be done to build consensus, align on collaborative approaches to bring solutions to scale, and arrive at common understandings of what needs to be achieved.

Walmart Is Closing the Loop

By Fred Bedore Senior Director, Operations Sustainability, Walmart
Anna Vinogradova Senior Manager, Operations Sustainability, Walmart

Walmart's aspirational goal to achieve zero waste across its global operations is aggressive; however, the company is continuing to make measurable progress. In the United States, more than 82% of the materials that flow through Walmart stores, Sam's Clubs, and distribution centers are being diverted from landfills.

"We are constantly thinking [about] how to maximize the recovery of more than 50 different materials, such as cardboard, plastics, metals, which are being generated in the back of our stores. We all know the 3 'R's' of sustainability—reduce, reuse, and recycle. At Walmart, there's a fourth 'R'—rethink," says Fred Bedore, Senior Director of Walmart Global Sustainability Operations team. "We worked with our suppliers in the U.S. on innovative solutions to direct recyclable materials from our facilities into the manufacturing of new products that come back to our shelves. This helps us to maximize the recovery of materials and helps reduce the cost of goods of products we sell in our stores."

These are a few recent examples of Walmart partnering with its suppliers to close the loop:

- In 2014, Walmart U.S. partnered with Pioneer Products to drive a closed-loop manufacturing program. Pioneer Products collected icing buckets used in Walmart store delis and difficult-to-recycle mixed plastics via an already existing reverse logistics network, and used the resulting resin to manufacture 45-gallon trash cans that are sold on Walmart shelves. During 2014, more than 215,000 icing buckets were recycled into more than 351,000 trash cans. The plastic resin contributed 10.9% of the trash-can makeup, and 95% of the icing bucket was able to be reused in the new product.
- Walmart U.S. and manufacturer Technimark are collaborating on a closed-loop program to recycle soft lines clothing hangers. Technimark's recycling arm, Wellmark Plastics, recycles clothing hangers collected at Walmart U.S. locations into retail hangers that are sold on its shelves. During 2014, this program generated enough recycled material to provide 25% recycled content in white and promotional hangers. Additionally, Technimark supplies 100% recycled black retail hangers to Walmart using Walmart's recycled hangers and recycled materials from other sources.

Walmart and its partners needed to work through variety of challenges to make closed-loop programs work: collection and consolidation of desirable commodities, selection of products to manufacture from more difficult to recycle materials, and establishment of agreements with vendors to guarantee feedstock while working to reduce waste across operations.

However, after launching several programs and showcasing business benefits from closing the loop on its own materials, more and more departments in Walmart merchandising organization are coming on board, and they have shown interest in testing the closed-loop approach for products in their areas.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