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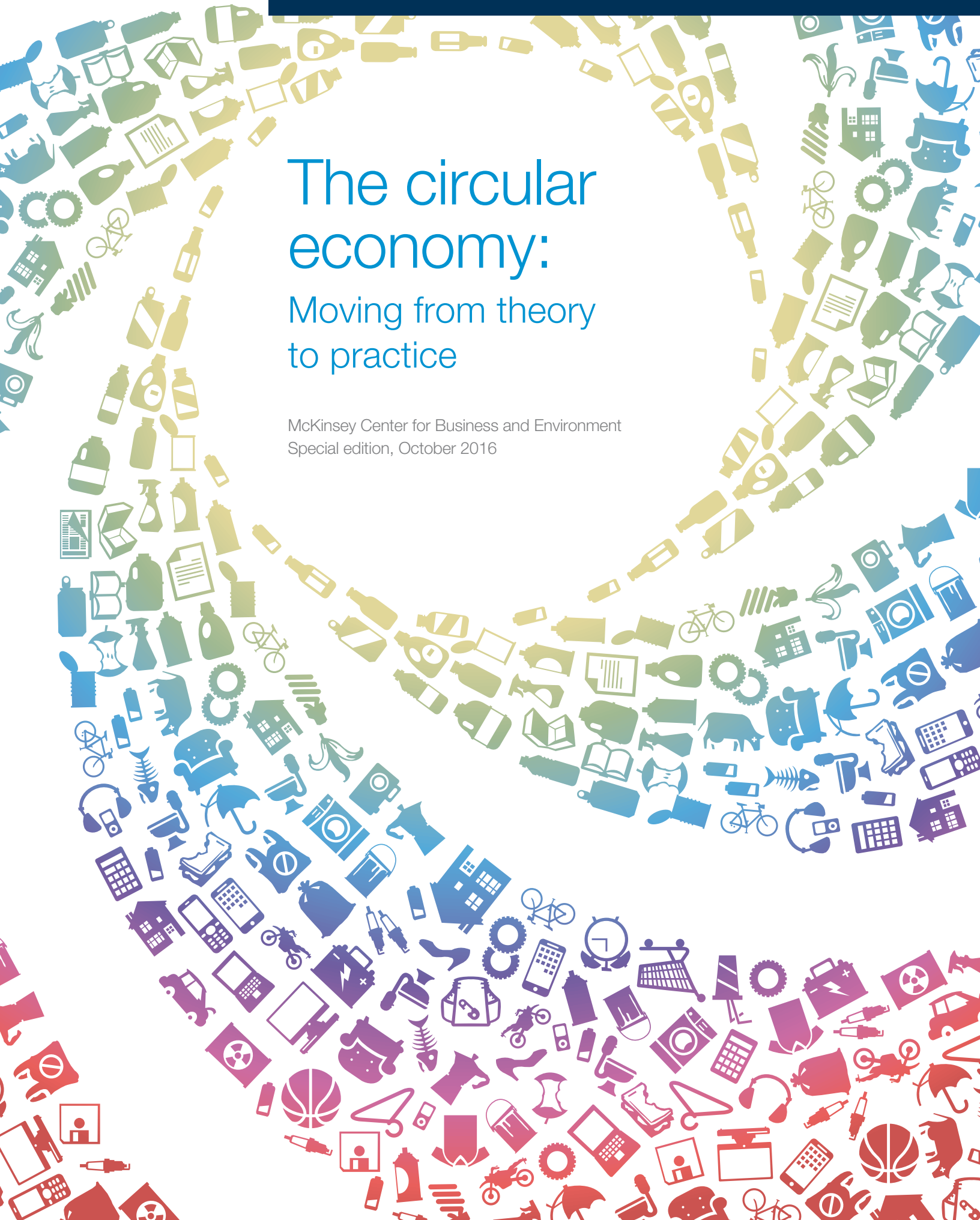

The circular economy:

Moving from theory to practice

McKinsey Center for Business and Environment
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The circular economy: Moving from theory to practice is written by consultants from across sectors and geographies, with expertise in sustainability and resource productivity.

To send comments or request copies, email us: Sustainability@McKinsey.com.

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Introduction

Eric Hannon, Clarisse Magnin-Mallez, and Helga Vanthournout

We are pleased to present this special collection of articles on the circular economy. Its subtitle, *Moving from theory to practice*, refers to the transition taking place as companies in many sectors use circular-economy concepts to capture more value from resources and to provide customers with better experiences. The term "paradigm shift" is overused, but this is one instance where it applies.

Since the Industrial Revolution, companies and consumers have largely adhered to a linear model of value creation that begins with extraction and concludes with end-of-life disposal. Resources are acquired, processed using energy and labor, and sold as goods—with the expectation that customers will discard those goods and buy more. Contemporary trends, however, have exposed the wastefulness of such take–make–dispose systems. The same trends have also made it practical to conserve assets and materials so maximum value can be derived from them.

Consider that resource prices have become more volatile and are expected to rise over the long term, as consumer demand increases and easy-to-access, high-grade stocks of key commodities dwindle. People and companies are increasingly willing to pay as needed to use durable goods, rather than to buy them outright. With digital technologies and novel designs, items can be tracked and maintained efficiently, which makes it easier to extend their useful lives. And governments are imposing new restrictions on pollution and waste that apply along entire product life cycles.

These developments mean that it is increasingly advantageous to redeploy resources over and over, often for the same or comparable purposes. This is the organizing principle of circular economies, and the benefits that come from following it can be substantial. According to the research documented in "Finding growth within: A new framework for Europe," a circular economy could generate a net economic gain of €1.8 trillion per year by 2030. The building sector, for example, could halve construction costs with industrial and modular processes. Car sharing, autonomous driving, electric vehicles, and better materials could lower the cost of driving by 75 percent.

The benefits are just as significant for less-developed economies. "Ahead of the curve: Innovative models for waste management in emerging markets" describes effective ways of encouraging the conversion of waste materials into valuable inputs. These include aggregating waste flows into large volumes that businesses can work with and establishing incentives to lessen waste creation. South Africa increased collection rates for scrap tires to 70 percent, from 3 percent, in just 18 months, leading to the creation of small and midsize processing and recycling companies. The country also aims to divert a majority of scrap tires into high-value material-recovery processes by 2020.

Similar possibilities inform our thinking about the global plastics economy, which produces high-performance materials for a wide assortment of applications but relies heavily on nonrenewable feedstocks and consigns too much plastic to the trash. "A new plastics economy: From linear value chain to circular system" points to innovations and practices that can lower the industry's need for virgin inputs and boost plastics reuse and recycling. Industry-wide standards for packaging formats and materials, for example, could make it economical to recycle more plastic by reducing its variety and increasing the volume of each plastic type.

"Developing products for a circular economy" offers another point of view on how to eliminate waste and create value: that of designers and engineers. It isn't easy to create products that are lasting, simple to reuse or recycle, and profitable. But when design teams get together with other company departments and use design thinking, they can conjure up resource-efficient ways of delighting customers. Greater collaboration allowed one medical-equipment company to figure out that collecting and refurbishing used devices would allow it to meet the needs of underserved customers in emerging markets.

Such opportunities are top of mind for Danone CEO Emmanuel Faber. In an interview, "Toward a circular economy in food," he describes how his company looks at every stage in the life of its products to overcome, and help solve, growing resource scarcity. "To embed the principles of the circular economy in our operations," he says, "we have started managing our three key resources—water, milk, and plastic—as cycles rather than as conventional linear supply chains."

Danone's rethinking of its operations is one example of how business-model innovation, based on circular principles, helps companies get ahead. More examples can be found among apparel companies, which are starting to reckon with the resource demands and waste associated with the business of fast fashion. "Style that's sustainable: A new fast-fashion formula" outlines how some clothing makers are getting ahead of consumer concerns by setting new design standards, improving materials and recycling technologies, engaging suppliers, and educating shoppers.

As other companies follow these pioneers in the transition from circular-economy theory to practice, they are certain to encounter obstacles. This is natural: breaking out of old models and letting go of time-tested approaches is challenging. But the lessons of the circular economy are accumulating—and they show that the gains from making the transition outweigh the effort and the risk. With those benefits in mind, we invite you to turn the page and learn more about how to reap the rewards of going circular. ■

Eric Hannon is a partner in McKinsey's Frankfurt office, **Clarisse Magnin-Mallez** is a senior partner in the Paris office, and **Helga Vanthournout** is a senior expert in the Geneva office.

Finding growth within: A new framework for Europe

How the circular economy could promote clean growth.

Morten Rossé, Martin Stuchtey, and Helga Vanthournout

How can Europe increase its prosperity, while reducing its dependence on primary materials and energy?

The circular economy is part of the answer to that question.

Instead of today's take–make–dispose linear model of production, the circular economy is restorative by design—using and reusing natural capital as efficiently as possible and finding value throughout the life cycles of finished products. Three major principles govern the circular economy:

- Preserve and enhance natural capital by controlling finite stocks and balancing the flow of renewable resources.
- Optimize resource yields by circulating products, components, and materials in use at the highest possible levels at all times.
- Make the system more effective by eliminating negative externalities.

Proponents argue that the circular economy offers Europe an opportunity to increase the productivity of resources, decrease dependence on them (as well as waste), and raise employment and growth. They maintain, too, that a circular system would improve competitiveness and unleash innovation. Skeptics say that European companies are already capturing most of the economically attractive opportunities to recycle, remanufacture, and reuse. Reaching higher levels of circularity, they argue, would incur substantial economic costs.

To contribute to a fact base that could inform this debate, last year the McKinsey Center for Business and Environment and the Ellen MacArthur Foundation developed the report *Growth within: A circular economy vision for a competitive Europe*, in association with the Deutsche Post Foundation. This 98-page document considered what a circular European economy could look like and compared its potential impact with the current development path. The report found that in the aggregate, the opportunities associated with a circular scenario could be large and that resource productivity remains hugely underexploited as a source of wealth, competitiveness, and renewal.

The analysis applied circular-economy principles and business actions to three sectors—mobility, food, and shelter—and defined a potential future state based on technology that will be available within five years. We then tested this vision in expert interviews. The circular scenario outlined here does not represent the most likely development path; it simply describes a technically viable future state. On that basis, by 2050, the report estimated, capturing all of the improvements as total-cost-of-ownership (TCO) savings could reduce mobility costs for the average European household by 60 to 80 percent, food costs by 25 to 40 percent, and housing costs by 25 to 35 percent.

Across the economy as a whole, we found that the circular economy, enabled by new technology, could help Europe to improve its resource productivity by up to 3 percent. By 2030, this surge would not only generate cost savings as high as €600 billion a year (and an additional €1.2 trillion in other benefits) but could also translate into a GDP increase of up to seven percentage points over the current development scenario. The promise of the circular economy, then, is significant.

In this article, adapted from the Ellen MacArthur Foundation report, we summarize the major conclusions of the research (part one) and then set forth the six ways businesses and societies can move toward a circular economy (part two).

Part one

What the research says: Seven conclusions

To create the report, we conducted more than 150 interviews, devised an economic model, and undertook the largest comparative study to date of the employment impact of a circular-economy transition. We also considered the academic literature. Our analysis yielded these conclusions.

The European economy still operates largely on a take–make–dispose basis. In 2012, the average European used 16 tons of materials—and only 40 percent of that was recycled or reused. In terms of value, material recycling and waste-based energy recovery captured only 5 percent of the original raw-material value. Even recycling success stories such as steel, polyethylene terephthalate (PET), and paper involve the loss of 30 to 75 percent of the value of the materials during the first use cycle. On average, European businesses and households use materials only once.

The analysis of sectors also found significant economic waste in some that many would consider mature and optimized. For example, the average European car is parked 92 percent of the time; 31 percent of Europe's food is wasted; and the average European office is used only 35 to 50 percent of the time, even during working hours. And use cycles are short: the average manufactured asset (excluding buildings) lasts only nine years.

This take–make–dispose system costs Europe €7.2 trillion every year for mobility, food, and the built environment. Of this sum, resource costs are estimated at €1.8 trillion. Related cash costs, including all other household and government expenditures, come to €3.4 trillion, and externalities (such as traffic congestion, carbon-dioxide emissions, and pollution and noise) to €2 trillion.

Disruptive technologies and business models could help Europe to raise resource productivity and cut costs. The digital and technology revolution could have a disruptive impact on many sectors of the economy. With regard to driving, for example, the average cost per car-kilometer could fall by up to 75 percent thanks to car sharing, autonomous and driverless driving, electric vehicles (EVs), and better materials. In food, precision agriculture could improve the input efficiency of water and fertilizers by 20 to 30 percent. Combined with no-tillage farming, this advance could reduce machinery and input costs by as much as 75 percent. In buildings, industrial and modular processes could cut construction costs in half compared with traditional on-site construction; passive houses could reduce energy consumption by 90 percent.

That is the potential. But it is not inevitable that it will be fulfilled. These sectors are mature and already the subject of much public policy, such as zoning laws, agricultural regulation, and building standards. They (and other sectors too) may therefore fail to integrate the new technologies effectively, so that much structural waste remains. Moreover, the rebound effects could be significant. When prices for a resource fall, consumers tend to use more of it, diminishing the desired outcome. Even considering such drawbacks, the report finds that in these three sectors alone, the savings could reach €900 billion a year by 2030.

By adopting circular-economy principles and integrating new technologies and business models, Europe could achieve 'growth within.' We call this the growth-within approach because it focuses on getting more value from the existing stock of products and materials, while decoupling value creation from resource consumption. The concept rests on three principles: preserve and enhance natural capital, optimize yields from resources

in use, and make the system more effective by removing negative externalities.

The approach outlined in the report would not only reduce structural waste and give consumers new choices but also create significant economic benefits. Getting there, though, requires a change of mind-set. Today, Europe has no established metrics for the utilization of key infrastructure and products. It does not measure their longevity or their success in raising GDP (still strongly emphasized) and preserving the value of materials and ecosystems.

A growth-within model would create better outcomes for the European economy, generating annual benefits of up to €1.8 trillion by 2030. Our models rely on multiple assumptions and need more research. Even so, we believe that pursuing opportunities that are already profitable, or close to that, could reduce Europe's resource spending by as much as 32 percent a year, or €600 billion, by 2030.

These resource benefits also come with a significant economic-multiplier effect. Benefits in other related cash costs could be as high as €700 billion. Externality costs could decrease by up to €500 billion. By 2030, the total annual benefit could be €1.8 trillion, twice that of the current development path. The modeling also suggests that benefits would continue to grow rapidly toward 2050.

The circular economy could produce better welfare, GDP, and employment outcomes than the current development path. The modeling for 2030 suggests that in the circular scenario, the disposable income of European households and Europe's GDP could be as much as 11 and 7 percentage points higher, respectively, than they would be under the current development path. A circular economy would also help to boost employment. A review of 65 academic studies indicated that while more research is needed, there would be "positive employment effects" if "a circular economy is implemented." This improvement would be largely attributable to increased spending fueled by lower prices and to the labor intensity of recycling activities and more highly skilled jobs in remanufacturing.

A circular economy could benefit the environment while boosting competitiveness and resilience. In a circular economy, economic growth would be decoupled from resource use. Across the three sectors of the study, carbon-dioxide emissions would drop as much as 48 percent from 2012 levels by 2030 (31 percent on the current development path) and 83 percent by 2050 (61 percent on the current development path). The principal sources of emissions cuts would be electric, shared, and autonomous vehicles; a reduction in wastage of food; regenerative and healthy food chains; passive houses; urban planning; and renewable energy.

Today, materials and components—40 to 60 percent of the total cost base of manufacturing firms in Europe—often create a competitive cost disadvantage. Europe imports 60 percent of its fossil fuels and metal resources, and the European Union has listed 20 materials as critical for security of supply. In the circular scenario, consumption of primary materials (measured by car and construction inputs, synthetic fertilizers, pesticides, water and land use for agriculture, fuels and nonrenewable electricity, and land for real estate) could drop as much as 32 percent by 2030 and 53 percent by 2050.

Moving toward a circular economy would incur considerable transition costs. R&D and asset investments, stranded investments, subsidies, and spending on digital infrastructure would account for most of these costs. There are no precisely

comparable situations, but the British government has estimated that creating a fully efficient reuse and recycling system would cost around €14 billion, which translates into €108 billion on a Europe-wide level. From 2000 to 2013, the renewables transition in Germany cost €123 billion in feed-in tariffs alone to operators of plants using renewable resources.

If managed well, though, this transition could also create opportunities for economic and industrial renewal: shifting to the circular model could contribute significantly to achieving Europe's growth, employment, and environmental objectives. Many previously underappreciated possibilities are now coming into focus. For instance, the European Commission's agenda for establishing a digital single market and an energy union could create the core infrastructure for a regenerative and virtualized system.

Building a strong foundation for the circular economy requires coordinated action. Shifting to a circular economic model will affect all sectors and policy domains. Here are four priorities:

- Learn about, research, and identify opportunities across Europe.
- Develop systems to preserve the value of materials.
- Create initiatives at the European, national, and city levels to facilitate the development of profitable circular business opportunities at scale.
- Design a new governance system to steer the economy toward greater resource productivity, employment, and competitiveness.

The timing is opportune. Essential enabling technologies are growing up. Europe is in the midst of a pervasive shift in consumer behavior. Business leaders are implementing product-to-service strategies and innovative business models. And at least for now, resource prices are easing, making it simpler to correct market and regulatory distortions.

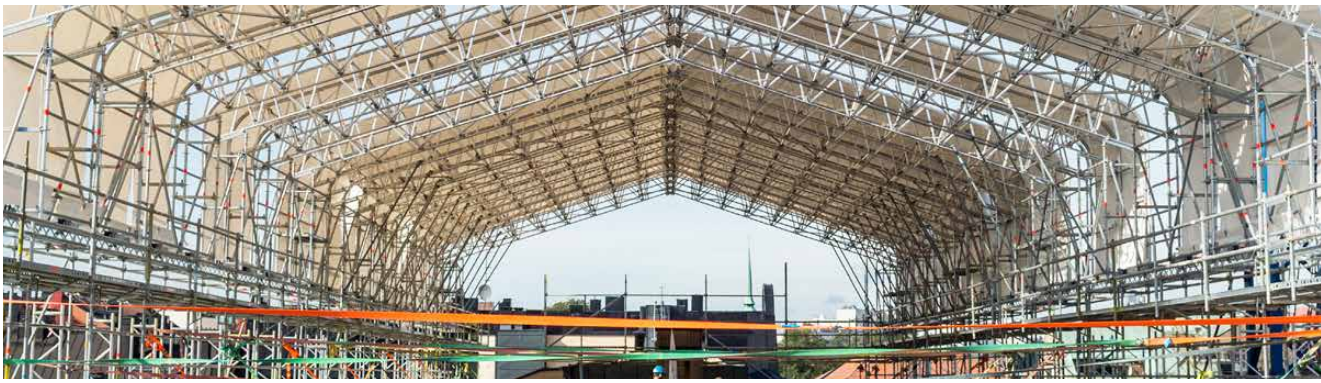
Part two

What to do: Six actions

Building a circular economy requires complex efforts at the local, national, regional, and global levels. To transition from the current trajectory to a circular one, European economies and companies must undertake six actions: regenerate, share, optimize, loop, virtualize, and exchange—the ReSOLVE framework.

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

Building a strong foundation for the circular economy requires coordinated action. Shifting to a circular economic model will affect all sectors and policy domains.



example, the Savory Institute's promotion of comprehensive land management has influenced the regeneration of more than 2.5 million hectares of commercial land around the world.

- *Share.* Maximize utilization of products through peer-to-peer sharing of privately owned products or public sharing of pools of products; reuse them throughout their technical life spans; and prolong those life spans through maintenance, repair, and design for durability. Examples include car- and home-sharing business models.

- *Optimize.* Improve the performance and efficiency of products; remove waste from their supply chains; and leverage big data, automation, and remote sensing. None of these actions requires changing products or technologies.

- *Loop.* Keep components and materials in closed loops and prioritize the inner ones. For finite materials, this means remanufacturing products or components and (as a last resort) recycling materials, as Michelin, Rolls-Royce, and Renault are doing. For renewable materials, it involves anaerobic digestion and the extraction of biochemicals from organic waste. In the United Kingdom, 146 anaerobic-digestion plants treat 66 percent of sewage sludge, and an additional 175 plants produce bioenergy from solid waste—a number that is growing rapidly.

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

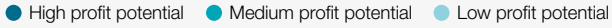
- *Exchange.* Replace old materials with advanced renewable ones; apply new technologies, such as 3-D printing and electric engines.

In different ways, these actions all increase the utilization of physical assets, prolong their life spans, and shift the use of resources from finite to renewable ones. Moreover, each action reinforces and accelerates the performance of the others. Separately and together, they could have a profound impact, increasing cost competitiveness substantially. Most industries already have profitable opportunities in each area (exhibit).

Not all of the technological advances will reduce costs; many might improve performance instead, and in some cases, the technology will need time to make a difference. But the analysis is persuasive: the circular economy carries a transformational potential that business—and society—would do well to take seriously. ■

Exhibit

A circular perspective can help many industries cut costs and improve performance.



Economic activities	Regenerate	Share	Optimize	Loop	Virtualize	Exchange
Information and communication services, media, and telecommunications	○	●	●	○	●	○
Scientific R&D; other professional, scientific, and technical activities	○	●	●	○	●	○
Education	○	●	●	○	●	○
Human-health and social-work activities	○	●	●	○	●	○
Administrative and support services	○	●	●	○	●	○
Arts, entertainment, and recreation	○	●	●	○	●	○
Financial and insurance activities	○	●	●	○	●	○
Legal and accounting, head-office consulting, and architecture	○	●	●	○	●	○
Distributive trades (including wholesale and retail trade)	●	●	●	●	●	●
Manufacture of wood and paper products; printing	●	●	●	○	●	○
Public administration and defense; compulsory social security	○	●	●	●	●	●
Real-estate activities	○	●	●	○	●	○
Manufacture of textiles, apparel, leather, and related products	●	●	●	○	●	●
Construction	○	●	●	●	●	●
Manufacture of transport equipment	○	●	●	●	●	●
Manufacture of furniture	●	●	●	●	○	○
Water supply, waste, and remediation	●	●	●	○	○	●
Manufacture of electrical equipment; computer, electronic, and optical products	○	●	●	●	●	●
Manufacture of machinery and equipment	○	●	●	●	●	●
Manufacture of rubber, plastics, and basic and fabricated metal products	●	●	●	●	○	●
Transportation and storage	○	●	●	●	○	●
Agriculture, forestry, and fishing	●	○	●	○	○	●
Manufacture of food, beverages, and tobacco products	●	○	●	●	○	●
Mining and quarrying	○	○	●	●	○	●
Electricity, gas, steam, and air-conditioning supply	●	○	●	●	●	●
Manufacture of coke, refined petroleum, and chemicals products	○	○	●	●	○	●
Manufacture of pharmaceuticals, medicinal chemicals, and botanicals	●	○	●	●	○	●
Accommodation and food-service activities	●	●	●	●	●	○

This article is adapted from a June 2015 report developed by the Ellen MacArthur Foundation and the McKinsey Center for Business and Environment, *Growth within: A circular economy vision for a competitive Europe*. The report was sponsored by SUN (Stiftungsfonds für Umweltökonomie und Nachhaltigkeit, or the Foundation for Environmental Economics and Sustainability), which is funded by Deutsche Post.

Morten Rossé is an associate partner in McKinsey's Munich office, **Martin Stuchtey** is an alumnus and former director of the McKinsey Center for Business and Environment, and **Helga Vanthournout** is a senior expert in the Geneva office.

Ahead of the curve: Innovative models for waste management in emerging markets

How countries can turn their garbage into wealth.

Hauke Engel, Martin Stuchtey, and Helga Vanthournout

As countries get richer, they create more garbage. Economic growth in emerging economies is raising living standards and reducing poverty, but there are also side effects, such as more waste of all kinds. To deal with it, countries need to build up waste-management systems that can reduce the risks to human and ecological health and curtail the degradation of urban and natural landscapes.

The Philippines is a case in point: it produces 2.7 million metric tons[1] of plastic waste per year—600,000 metric tons in metro Manila alone.[2] While the country has high waste-collection rates (84 percent nationwide), 17 percent of collected plastics gets dumped into the ocean after collection because of illegal dumping and poor landfill siting and operating practices. For uncollected plastics, the rate of leakage into the ocean is 31 percent. The economic effects on tourism, fisheries, and healthcare are considerable. We estimate that each metric ton of uncollected mixed waste represents an average loss of about $375.[3] Many municipalities are struggling to keep up; indeed, that has been the case for decades.[4]

While the importance of protecting the ecosystem is well understood, the costs of dealing with waste can be burdensome. Municipalities in developing countries are already spending 20 to 50 percent of their budgets on solid-waste management.[5] The default solution has been to encourage private-sector operators to get involved. This can relieve the financial pressure and add much-needed expertise, but it does not necessarily guarantee value recovery, since this is usually not an explicit part of their mandate. In this article, we suggest how governments can turn waste into economic value and how they can develop incentives to avoid creating waste in the first place.

Accessible value pools

With the right approach, and using available technology, many waste streams can become income streams. For example, pound for pound, there is more gold in electronic scrap than in gold ore[6]; collecting and selling used polyethylene terephthalate (PET) bottles can earn a waste picker a living ($3.70 a day).[7]

Nevertheless, the value in many waste flows is not being captured today. Even the stable and relatively successful systems for PET bottles and fiber recovery fail to extract most of their potential value.[8] Why is this so? And how could the management of such relatively low-value products and materials be rendered profitable?

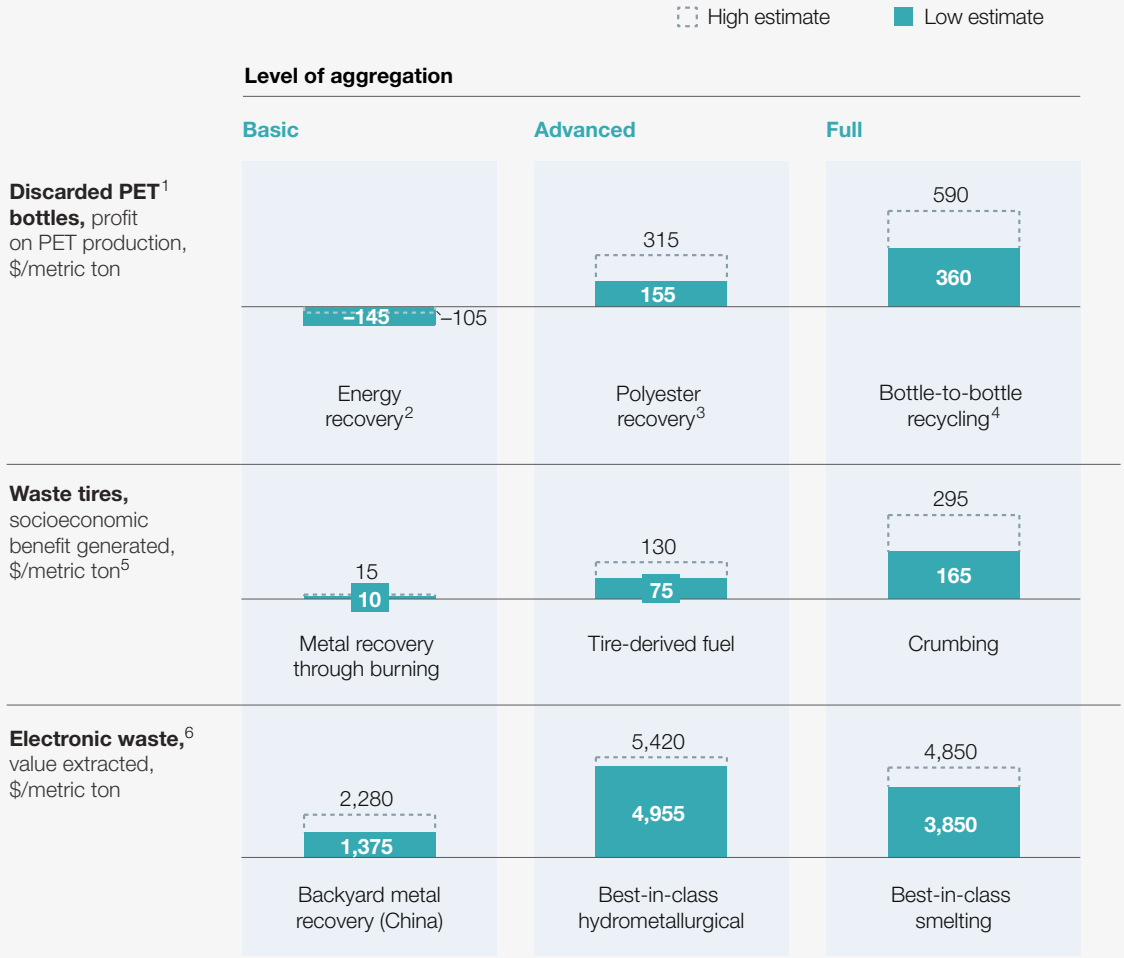
Our analysis suggests that the aggregate extractable value from consumer waste flows is higher than current recovery rates imply. Greater scale and volume are needed to justify investment in technology and infrastructure that are capable of extracting more value. Consumer materials and products are widely dispersed; there is also a need for integrated infrastructure and well-managed supply chains.

In emerging economies, there are two keys to success for waste-management systems. The first is to aggregate waste flows into meaningful volumes around which businesses can be developed. The second is to organize efficient supply chains that operate at a high level of environmental and social effectiveness.

The exhibit shows how aggregation and organization could create value across three types of waste material. The PET-bottle collection system that requires the lowest level of aggregation—collecting PET bottles as part of mixed waste—allows for energy recovery via incineration, but its economic yield is low. At the next level, recovering the bottles' material value via a mixed-recyclables or mixed-plastics stream could yield about $150 to $300 per metric ton. The highest values, from $360 to $590 per metric ton, require the highest level of aggregation, in the form of a bottle-only collection

Exhibit

Aggregating flows and providing necessary scale can yield high-performing value recovery.



[1]Polyethylene terephthalate.
[2]Assumes no additional sorting.
[3]Collected as part of mixed waste.
[4]Bottles separated at source and collected as single stream.
[5]South Africa, steady state. Exchange rate: $1 = 10 South African rand (average 2013–15); socioeconomic benefit includes operating profit, wages, interest and rent, taxes, R&D investment, social uplift and education spending, and is net of public investment (fees levied).
[6]Copper recovery from mobile-phone boards.

Source: *Plastics News*; Umicore; United Nations University/Step Initiative; WRAP

system. Metals are commonly extracted from tires in small backyard operations where tires are burned in open fires—at great cost to health and the environment. Aggregating tires to feed them as fuel into industrial processes could increase the value extracted almost tenfold. When processes to recycle specific materials (not just using tires as industrial fuel) are added, the value could double again. The same idea works for electronic and electrical waste, shifting from small-scale recycling to using it as feedstock for smelters.

How aggregation can work—fast

Solutions for aggregating and organizing solid-waste flows already exist at the municipal and regional levels, providing some instructive examples that show how this can be done in a way that creates significant economic value and changes the material supply chain.

Take organic waste. It typically makes up around 30 percent of household waste in developed countries, and up to 65 percent in developing ones.[9] It is the biggest source of odors and pests in places where collection services are inadequate, causes groundwater contamination, and contaminates other materials, reducing their recycling value. There are a number of successful programs to divert organics away from conventional landfills or incinerators. In Flanders, for example, diversion volumes for organic household waste via municipal channels grew from nothing to more than 350,000 metric tons in ten years.[10] Toronto and Portland, Oregon, also have successful programs. Portland bans all nonfood items, even compostable ones, from its organics flow in order to produce better-quality composts.

Successful programs are not limited to developed countries. In Telangana, a state in southeastern India, a group of young entrepreneurs founded Waste Ventures India (WVI), which turns municipalities' organic waste into compost. WVI charges competitive rates for its collections; it expects future projects to be profitable within the first 13 months of operations. Based on current capital-expenditure projections, an internal rate of return of 23 percent is expected.

In 2012, South Africa set up the Recycling and Economic Development Initiative of South Africa (REDISA) to collect scrap tires and send them to processors. Collection increased from 3 percent when the program started to 70 percent just 18 months later. REDISA has also started to develop treatment capacity, with the goal of having all recoverable scrap tires collected and treated within the country. By 2020, the initiative plans to have the majority of scrap tires going into a high-value material-recovery process.[11] REDISA's efforts create both economic and environmental benefits. The collection and sorting of recyclables, such as tires, can provide livelihoods for many people, and processing and recycling has led to the creation of a number of small and medium-size companies. Up to ten full-time jobs are created per 1,000 metric tons of tires REDISA collects. By 2020, REDISA is expected to deliver an aggregated economic benefit of $6 million. In addition, systematic collection and reuse means that tires are not burned outdoors, an environmental and health hazard concentrated in poor communities.

Success factors—today and in the future

From strong roots in Europe, product-stewardship programs are growing around the world—for electronic waste in China, plastic packaging in Tunisia, and various material flows in Brazil. Some of these operations are industry owned, and some are run by third-party organizations or government agencies. Regardless of who is in charge, the most successful programs share a number of common elements. Three factors in particular make a difference.

Economic viability. A thriving resource-recovery system requires a strong balance sheet. Recyclers or other downstream users of the waste must be comfortable enough with the numbers to invest. This is essential to build enough capacity to absorb most if not all the collected materials. Companies also need access to feedstock of sufficient quality and quantity. Reliable off-take agreements, with assurances on volume and consistency, are essential in order to plan, invest, and create product flows that allow investors to see this as commercially and operationally possible.

REDISA, for example, supports the development of processing capacity by researching new

options and supporting the start-up phase of new facilities. It also lowers the barriers to access by entering into contractual agreements with the various tire processors and guaranteeing them a minimum volume of feedstock.[12] For such feedstock guarantees to be credible, processors and other partners need to be able to hold the management of a waste-management operation accountable.

Private-system operators need to have a strong, externally audited balance sheet and cash-flow position. If the system operator is an industry itself, the companies behind it can be held liable; if run by the government, the public sector usually assumes the risk. In the model pioneered by WVI, the company worked out a contract with the local government in which the authorities provided the land, a shed, and equipment in lieu of monetary payment.[13]

Transparency. When a private company takes on system management, maintaining full transparency—meaning that it not only keeps track of important metrics but also makes them available—is critical. Transparency builds credibility with system suppliers and partners and facilitates government monitoring of environmental, health, and social outcomes. It also enables producers that pay into the system to assess efficiency and continuous-improvement efforts. Internally, such visibility allows the company to make adjustments to collection, treatment methods, and systems management, and can inform its work with regulatory authorities.

WVI tracks indicators on both poverty and job creation; it has also built a full-fledged IT infrastructure to track its impact and business metrics. REDISA maintains a detailed management dashboard, reports to the South African authorities on a monthly basis, and is audited every year. Its advanced IT systems help recognize pockets of value (and the absence of such value) and thus support management decision making. REDISA has also built tracking facilities across the country.

Strong management. Particularly in developing countries, waste management has been dominated by the informal economy. Given the economic and social importance of waste recovery, a more industrial approach, stronger performance management, and better talent, all supported by analytics that inform strategic and operational decisions, are necessary to do better.

REDISA's top team has extensive management experience in business, backed by strong academic credentials.[14] WVI has complemented its local leadership team with analytical and innovation talent. It has studied in detail the needs and motivations of informal workers in waste management and adjusted compensation models accordingly.[15]

Planning for value creation

Actions that address waste problems now can shape materials markets for decades; paradoxically, that means that they could lock out superior solutions that emerge, such as new materials or waste avoidance. Countries that have a dense incineration infrastructure, for example, may find it more difficult to create a robust recycling market. It is feasible, however, to tackle immediate issues while establishing a framework to create value in the future. To do so requires a system that respects the principles of the circular economy. Today's waste system is often linear—use an item, then dispose of it in a landfill. A circular waste system creates additional economic, environmental, and social value through recycling or reuse. These practices extend the useful life of a product and diminish the use of resources. Eventually, there could be a new generation of regenerative materials.

WVI's operations are compatible with circular solutions. It started out with composting, which

fulfills the immediate need to reduce the volume of material and thereby reduce the emissions of greenhouse gases. Moreover, it yields sellable products, such as compost. But WVI is also considering anaerobic digestion or the production of refuse-derived fuel in its new contracts.

REDISA, too, is developing infrastructure for commercially and environmentally preferable treatments. For example, its IT system is able to support product tagging, which can improve recovery and serve as an incentive for improved tire design. Producers that make tagged tires with less toxic materials can be rewarded with a more attractive tariff. REDISA is stimulating research into such designs.

In Europe, governments have sought to meet the European Union's regulations on electronic waste by focusing on the safe disposal and recycling of materials. These efforts have proved effective in avoiding the worst risks to environmental and public health. In the future, they could also be complemented with incentives to move beyond recycling, toward design for disassembly, for example, or with creating refurbishment programs.

Conclusion

In many developing countries, the volume of waste is growing faster than can be adequately handled. In addition to increasing collection and reducing the volume of waste, they need systemic solutions—from waste avoidance to reuse—to deal with this problem.

The benefits of better waste management have been established, and there are approaches that work. Moreover, there are few areas where entrepreneurial success comes with more benefits—to both the economy and to society at large. This is cause for optimism. ■

[1] One metric ton = 2,205 pounds.

[2] *Stemming the tide: Land-based strategies for a plastic-free ocean*, joint report by McKinsey Center for Business and Environment and Ocean Conservancy, September 2015, oceanconservancy.org.

[3] Based on the five countries examined in the study referenced here: China, Indonesia, Philippines, Thailand, and Vietnam.

[4] Inge Lardinois and Arnold van de Klundert, *Community and private (formal and informal) sector involvement in municipal solid waste management in developing countries*, Ittingen Workshop, Ittingen, Switzerland, April 12, 1995, gdrc.org.

[5] Ephraim Joseph Camenzind, Christian Riuji Lohri, and Christian Zurbrügg, "Financial sustainability in municipal solid waste management: Costs and revenues in Bahir Dar, Ethiopia," *Waste Management*, 2014, Volume 34, Number 2, pp. 542–52, sciencedirect.com.

[6] "E-waste: Annual gold, silver 'deposits' in new high-tech goods worth $21 billion+; less than 15% recovered," United Nations University, July 9, 2012, unu.edu.

[7] *Stemming the tide*.

[8] *Growth within: A circular economy vision for a competitive Europe*, joint report by Ellen MacArthur Foundation, the McKinsey Center for Business and Environment, and SUN (Stiftungsfonds für Umweltökonomie und Nachhaltigkeit, or the Foundation for Environmental Economics and Sustainability), ellenmacarthurfoundation.org.

[9] David C. Wilson et al., "Comparative analysis of solid waste management in 20 cities," *Waste Management & Research*, 2012, Volume 30, Number 3, pp. 237–54.

[10] *VLACO Jaarverslag 2013*, EcoWerf, 2013, ecowerf.be; *Inventarisatie huishoudelijke afvalstoffen*, OVAM, 2008, ovam.be.

[11] "National Environment Management: Waste Act (59/2008): Notice of approval of an integrated waste tyre management plan of the Recycling and Economic Development Initiative of South Africa," *Government Gazette*, 2012, Volume 569, Number 35927, sawic.environment.gov.za.

[12] The Recycling and Economic Development Initiative of South Africa also plans to introduce tracking of more precise product composition, thereby enabling guarantees not only for volume but also for quality (and hence potentially higher prices for the most desirable grades).

[13] Circular on compost shed, Municipal Administration Department Hyderabad, 2013.

[14] Interview with Hermann Erdmann, CEO, Recycling and Economic Development Initiative of South Africa, July 2015.

[15] Interview with Parag Gupta, chairman, Waste Ventures India, July 2015.

Hauke Engel is a consultant in McKinsey's Frankfurt office, **Martin Stuchtey** is an alumnus and former director of the McKinsey Center for Business and Environment, and **Helga Vanthournout** is a senior expert in the Geneva office.

A new plastics economy: From linear value chain to circular system

Remaking the plastics economy will require innovation in recycling and reuse as well as in design and chemistry.

Martin Stuchtey, Steven Swartz, and Helga Vanthournout

Plastics are the workhorse material of the modern world. Their low cost, versatility, and toughness have made them essential to industries as varied as consumer packaged goods, healthcare, technology, and transportation. According to ICIS, the use of plastic worldwide is expected to increase by more than 4 percent a year between 2010 and 2025. That rate would exceed most estimates of global economic growth.

For all its success, the plastics economy has drawbacks. One is that production relies almost entirely on feedstocks of nonrenewable resources. Another is that too much plastic ends up in landfills or as litter. Some 95 percent of the value of plastic packaging, $80 billion to $120 billion per year, is lost after a single use. Making and disposing of plastics can also harm natural systems. The UN Environment Programme estimates the environmental costs of plastic packaging at $40 billion—more than the industry's total profits. Finally, there are concerns about the risks to human health that may be associated with chemical substances used to make some plastics.

How can the plastics economy address these drawbacks while creating value? One promising approach is to shift away from linear, take–make–dispose modes of production and use. A new plastics economy might be underpinned instead by circular-economy principles, which call for reusing materials efficiently and thereby minimizing the depletion of natural resources and the creation of waste and pollution.

One relatively simple step toward a new plastics economy would be to improve waste-management systems. A small number of changes—all drawing on existing technologies and know-how—in just five countries could lower the amount of plastic waste that enters the ocean by 45 percent over the next ten years.

To remake the plastics economy as a circular system, however, far-reaching efforts are needed. The first task is to improve the economics of plastics reuse and recycling. And the second task is to find ways of making plastic products that lower the need for virgin materials, especially fossil fuels. Carrying out these tasks will require participants in the plastics economy to set shared goals and standards. Just as important, they will need to work together on innovative programs that improve the resource productivity of the plastics economy.

Capturing the value of used plastic

The cornerstone of the new plastics economy is a better model for managing plastics after they are used. In such a model, new materials, designs, policies, and market mechanisms would greatly increase rates of reuse and recycling and boost the value of after-use plastics. These changes would reduce the amount of plastic waste that gets sent to dump sites or escapes waste systems, ease the plastics industry's reliance on fossil fuels as raw materials, and cause more plastic to recirculate within the economy.

Reuse

Reuse makes packaging and other forms of plastic a much more productive resource. Even though reusable packages often contain more material than single-use ones, their per-use material requirements are much lower when averaged over a reasonable life span. Making reuse a common practice, however, will require companies and consumers to embrace new behaviors.

In the business-to-business segment, sturdy plastic containers fitted with radio-frequency-identification (RFID) tags can make products easier to handle, protect them better, and simplify inventory management. Over the long term, this could make the logistics sector more efficient by helping to eliminate the phenomenon of partly filled cargo

Plastics recycling is not only limited but also inefficient, causing losses of 60 percent of the value of the raw materials.

vehicles traveling to and from single destinations. A digitally connected system of logistics equipment would let businesses transport goods in a coordinated manner: imagine a full or nearly full vehicle making a series of deliveries and pickups for multiple clients on the same trip, without having to trash countless single-use containers.

Some companies have taken up these ideas. Sweden's Svenska Retursystem maintains a pool of reusable crates and pallets that most of the country's food manufacturers rely on. Brambles is an Australian service company with 500 million reusable pallets, crates, and containers that serves thousands of clients in more than 60 countries. Some 850 Brambles service centers see that container sizes and network protocols stay consistent, while maintaining the flexibility to fulfill sector-specific demands.

In households, innovative designs for consumer goods can encourage people to reuse plastics. Some companies sell refilling systems that let people mix tap water with concentrated ingredients sold in minimal packaging. The result: common solutions, such as liquid soap and soft drinks, in plastic containers that can be used over and over. In certain product categories, deposit-and-return systems, like those that have worked for glass bottles, could be set up for reusable plastic containers.

Municipal initiatives and industry-led agreements could also compel the makers of consumer goods to switch to reusable packaging. Some municipalities, for example, are installing more drinking fountains and bottle-filling stations. In France, a voluntary agreement among hypermarket chains reduced the number of plastic shopping bags from 10.5 billion in 2002 to 700 million in 2011.

Recycling

Almost all plastics used for packaging can be mechanically recycled with little sacrifice of quality. In fact, only 14 percent are. Plastics recycling is not only limited but also inefficient, causing losses of 60 percent of the value of the raw materials. Recycled plastics mostly go into lower-value applications, such as trash bags, for which further recycling is economically impractical.

The most important reason for this poor performance is the lack of global standards. Because materials, formats, and labeling requirements have proliferated, many types of packaging are produced in quantities that are too small for recyclers to readily make money from. Collection methods and processing systems vary, too: what's recyclable in one city may not be in another. Moreover, packaging changes all the time, and local waste-collection and recycling programs struggle to keep up.

By contrast, some types of packaging, such as beverage bottles, are ubiquitous and therefore recycled widely. When recyclers know they can collect certain plastics in significant quantities, they are more willing to make investments that enable them to produce high-quality recycled materials at competitive prices and in large volumes.

Even under those conditions, recycled plastics can be difficult to sell. Within any given category of recyclable plastic, batches of recycled material should be commodities, distinguished only by their price. But the wide variety of packaging types and processing technologies means that recycled batches of a particular plastic can have different grades and properties. This makes it hard for prospective buyers to know just what they are getting.

To make plastics recycling more widespread and efficient, participants in the plastics value chain will have to resolve these many inconsistencies. A good first step would be setting standards. A single set of standards for packaging materials and formats could reduce the variety of plastic packaging so that more types become economically appealing to recyclers. Standards for waste collection and sorting could give buyers of recycled plastics more confidence that their purchases have the specifications they are seeking.

As packaging makers and consumer-packaged-goods companies consider new materials and formats, they could work with waste-collection and recycling organizations to choose recycling-friendly options. Better technologies for sorting and processing plastic waste, including chemical and mechanical recycling, could accommodate a broader range of materials and increase the quality of recycled plastics.

Other measures could strengthen markets for recycled plastics. Voluntary pledges by manufacturers can help stimulate demand, as could mandates specifying that public agencies buy items made of recycled plastic. Public policies can also encourage recycling, such as requirements that manufacturers take responsibility for the disposal of the goods they sell or restrictions on landfilling and incineration.

Making plastics without fossil fuels

Oil and gas make up more than 90 percent of the plastics industry's feedstocks. Each year the industry uses as much fossil fuel as the global aviation sector. Even if the global recycling rate were to rise from 14 percent to more than 55 percent—better than in the best-performing countries—the quantity of fossil fuels used to make plastics would still double by 2050.

Two tactics stand out for lessening the plastics economy's demand for fossil fuels. Over the past 40 years, many companies have made their plastic packaging lighter. This does reduce the amount of plastic per item, but it can also close off options for recycling; superlight packaging may have too little value to appeal to recyclers. Some efforts to make packages lighter have involved using multimaterial designs that are hard to recycle. In other cases, packages cannot be made lighter without compromising quality.

Still, interesting possibilities are emerging. For example, nanoprinting, which permits objects to be assembled at the micron scale, could be used to turn a single, easily recycled material into packages that can now be made only from multiple materials. Digital methods of manufacturing and distribution, such as localized small-batch 3-D printing, could also change companies' needs for plastic packaging.

Switching feedstocks from oil and gas to renewable resources, such as sustainably sourced biomass and captured greenhouse gases (GHGs), is another way to lower the industry's fossil-fuel consumption. This is a long-term proposition. Technically, today's bio-based plastics could replace about 60 percent of the petro-based plastics in packaging. But they cannot compete on cost, and GHG-based materials have not yet proved viable at scale.

Beginning a new approach

Ushering in a new plastics economy will require participants—companies in multiple sectors, governments, and nongovernmental organizations—to collaborate as never before, particularly on innovation. Here are four priorities to establish a foundation for sustained collective efforts to reform the plastics economy.

Establish global standards. This is a necessary basis for innovation, as is guidance on design, labeling, infrastructure, and secondary markets. Standards would help recyclers to produce uniform batches of material and would give plastics manufacturers confidence that they are buying recycled plastics with properties that meet their needs.

Develop economic and scientific knowledge. What is the socioeconomic impact of plastics in the ocean? Can energy be recovered from plastics that cannot be recycled effectively? Research that clarifies these and other matters would inform decisions about long-term options for managing plastics.

Collaborate on innovation. Businesses and researchers could work together to define practical, focused efforts to develop new technologies. These might include biologically benign plastics, multimaterial packaging that can be reprocessed easily, and improved methods of chemical recycling.

Engage policy makers. Government officials need up-to-date tools, data, and insights related to plastics. For instance, they could benefit from a methodology for assessing opportunities, barriers, and policy options related to the transition toward a new plastics economy.

For decades, plastics has been a creative and profitable industry. Nearly everyone, everywhere has benefited from the widespread use of these versatile materials. But a lack of coordination has prevented participants in the plastics economy from seizing opportunities to make the system more effective and to reduce pollution, waste, and other costs to society. By setting shared goals and standards and by collaborating on innovation programs, the plastics industry can generate more value for participants and consumers alike. ■

Download the full report on which this article is based, *The new plastics economy: Rethinking the future of plastics*, a joint effort by the Ellen MacArthur Foundation, McKinsey, and the World Economic Forum, on McKinsey.com.

Martin Stuchtey is an alumnus and former director of the McKinsey Center for Business and Environment, **Steven Swartz** is a partner in McKinsey's Southern California office, and **Helga Vanthournout** is a senior expert in the Geneva office.

Developing products for a circular economy

Cross-functional collaboration and customer-focused design thinking can help companies reap more value from the energy and resources they use.

Eric Hannon, Marianne Kuhlmann, and Benjamin Thaidigsmann

Over the past 150 years, companies have steadily refined their ability to invent products and produce them efficiently, delivering a wide range of goods to consumers and improving financial returns to shareholders. In other respects, however, this system is far from optimal. Specifically, companies have hardly begun to reckon with the waste that occurs after products are purchased. When a consumer uses a product infrequently or discards it because it has worn out, at least some of the energy and material that went into making the product has been wasted.

Things don't have to be this way. Some businesses are using circular-economy principles to create products that are durable, easy to reuse or recycle—and profitable. Nothing about this is easy, but two tactics can help.

The first is devising a highly collaborative product-development process that both accounts for and helps to determine sourcing requirements, production methods, marketing, sales, and other aspects of how goods are made and how they are handled at the end of their lives. The second is to use design thinking, which can help companies discover unexpected ways of meeting customers' needs with much greater resource efficiency than in the past.

In this article, we explore how these tactics can help companies capitalize on the opportunities that the circular economy presents.

How collaboration helps companies develop circular-economy products

Few companies consider what happens to their products after they are purchased. The tacit assumption is that people will eventually throw them out and buy new ones; local waste collectors will take care of the discards.

Mechanical components, for instance, tend to be designed with ease of manufacturing in mind, because that makes them less expensive. This priority leads to design choices like snapping pieces together rather than joining them with removable fasteners. Making a part easy to manufacture, though, can make it all but impossible to disassemble or repair. Its fate is to be discarded, then replaced.

Now suppose the product-development process were to begin from a different premise, derived from the idea of a circular economy. Instead of considering only functionality and cost and assuming that products will be thrown out, a company would look at how it might manage the entire life cycle of its products in order to maximize the value of them and their component materials. For mechanical components, a manufacturer might give customers rebates for returning end-of-life parts so the manufacturer can refurbish them for resale at a lower price or dismantle them for recycling.

Circular-economy principles can be seen at work today in the mobile-phone sector. Some handset makers sell refurbished units of their own phones at a discount. Independent companies have also emerged to capture the residual value of used, older-model phones that still function. They collect these phones, fix them, install fresh software, and sell them, especially in markets where many people cannot afford or do not need the latest models.

The secondary market for mobile phones hints at the opportunity for consumer companies to retain more of the value of the material and energy they use to make their products. It also points to the business-model changes required to seize that opportunity, which begin with product development. Developing a product that a company can manage over its life cycle requires more collaboration than is customary. The product design has to be conducive to reuse, repair, and recycling. And the company needs processes and systems for helping customers when products wear out, approach obsolescence, fail, or no longer provide satisfaction.

Since these matters affect procurement, marketing, sales, and other company departments, as well as suppliers, freight carriers, distributors, retailers, and entities all along the value chain, all those departments and organizations need to have a say in product development. This is seldom the case today. Product developers typically receive specifications and design products accordingly.

When product development is a collaborative process involving the whole value chain, profitable breakthroughs are more likely to occur. At one medical-equipment company, for example, the sales department was given ambitious targets in emerging markets—and a portfolio of high-priced products. Bringing together sales, product development, and other teams revealed this problem and gave product developers a chance to help solve it. They figured out that by refurbishing used medical equipment from developed countries, the company could offer a lineup that would be appealing and affordable in emerging markets.

The medical-equipment company's experience illustrates another benefit of making the product-development process more collaborative: it helps companies center the process on customers' needs rather than product specifications. And when it comes to creating products with customers first in mind, one especially effective method is design thinking, a user-centered design approach that focuses on finding the best way to meet customers' needs, rather than the best way to design products.

How design thinking reinforces circular-economy principles in product development

Design thinking starts with observing customers in their everyday lives to learn about their material needs and about how well (or poorly) those needs are met by existing products. Product designers, marketing specialists, engineers, and others involved in making and selling products use the resulting insights on customer needs to rapidly prototype, test, and refine new concepts for products and services, without relying on old assumptions that might constrain their ideas.

With respect to the circular economy, design thinking also means asking how to provide value to consumers using a minimum amount of material. Sometimes the answer is to offer services rather than products: think of how some people choose to store digital files in the cloud rather than on their own devices. If a physical unit is needed, design thinking might suggest that companies make their products more durable by using better materials, or make them easy to maintain with designs that allow critical components to be replaced when they wear out.

These concepts led the flooring company Desso to introduce a carpet-leasing service. Instead of buying carpet, customers now have the option to lease carpet from the company, which takes care of installation, maintenance, and removal. This arrangement gives Desso an incentive to manage materials efficiently. Indeed, Desso has cut waste and reduced its consumption of virgin material by treating old carpet as a valued commodity. The company collects carpet from its customers and other sources, including its competitors, and removes the fibers from the backing. The old fibers are recycled into new fibers; the backing is used as an ingredient in roads and roofs.

Understanding the possibilities associated with circular-economy ideas requires the expertise of many company departments as well as business partners. Design thinking thus relies on the sort of collaboration that is central to developing circular-economy products. In a design-thinking process, the company would start with a one- or two-day working session with all the affected departments and other organizations in the value chain. Participants would

discuss customer needs and relevant business operations—particularly manufacturing and service—and come up with ideas for new offerings as well as the business-model changes needed to support them.

Given those concepts, the product-development team would create prototypes. The prototypes would be shared with the same groups from the initial meeting and discussed in another working session. Product developers would then refine their designs for further consideration by the wider group of stakeholders. This process would continue until the product is ready to be made and the business changes required to support it have been defined by the relevant departments. The final decision to bring out the product is also thus a choice about reorganizing the business so it can capture maximum value from the new product over its entire life cycle.

Reorienting business models and practices along these lines requires levels of collaboration and creative thinking that are far from familiar. So why should companies bother? One reason is that they face increasing pressure from consumers and governments, particularly in developed countries, to be better stewards of resources and the environment.

Another reason is to pursue a major financial and economic opportunity. Research suggests that each year some $2.6 trillion worth of material in fast-moving consumer goods—80 percent of the material value—is thrown away and never recovered.[1] In a circular economy, more of this material would be used again in some form. In Europe, the net benefit of applying circular-economy principles could be as much as €1.8 trillion annually by 2030 (see "Finding growth within: A new framework for Europe," on page 4). Companies that successfully design products for a circular economy stand to capture considerable value and create lasting, rewarding relationships with customers. ■

[1] *Towards the circular economy Vol. 2: Opportunities for the consumer goods sector*, Ellen MacArthur Foundation, January 2013, ellenmacarthurfoundation.org.

Eric Hannon is a partner in McKinsey's Frankfurt office; **Marianne Kuhlmann** and **Benjamin Thaidigsmann** are consultants in the Berlin office.

Toward a circular economy in food

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Danone CEO Emmanuel Faber shares how his company manages resources with an eye on sustainability.

The French food and water company Danone has a history of environmental awareness. In this interview with McKinsey partner Clarisse Magnin-Mallez, CEO Emmanuel Faber discusses his commitment to resource efficiency.

McKinsey: *What inspired Danone's current thinking?*

Emmanuel Faber: Three things. My own upbringing and convictions, the culture and history of Danone, and the overwhelming case for change.

I grew up in the Alps, where the beauty of the natural cycles seeded in me the underlying importance of something that we as managers can often lose sight of—namely, that life is more than ideas, mathematical models, and software. I later spent three years in Asia, including Indonesia and China, where I saw firsthand how fast resources were being depleted in emerging markets.

Danone's commitment to tackling these problems is not new, so it was always fitting that I should join such a company. More than 40 years ago, in Marseille, Antoine Riboud, our founding CEO, made a speech in which he pointed out that we only have one Earth, that it's our responsibility to look after it, and that as a business we would pursue a dual economic and social agenda.

Last, the world is changing. Cheap, low-quality calories have dominated the industrial-food business for nearly 100 years, but we are reaching the end of this era. Consumer tastes and behaviors are evolving, and as part of this evolution, consumers expect us to act differently.

McKinsey: *Can you say more about these changes?*

Emmanuel Faber: Supply chains are increasingly global, which means there are systemic risks that we don't see. While we've been able to improve food security in many regions, this has also led to other issues, such as declining soil fertility and threats to the biodiversity of our planet. At the same time, we cannot continue to reduce the costs of agricultural production. The volatility of input prices is much greater than it used to be, and food inflation is rising. The price of milk, our major raw material, was near an all-time low in 2009 but has gone up three times since and 18 months ago almost hit an all-time high.

On top of that, we need to address the needs of a growing population, new regulatory requirements in the area of public health, and the increasing impact of diseases such as obesity and diabetes. Some companies are turning to big data management and ERP[1] to meet these challenges. But I believe this is the wrong approach. We need a comprehensive response to tackle growing resource scarcity, which both drives the efficient use of those resources through the supply chain and brings healthy food to as many people as possible. Danone's approach rests on what we call consumption ecosystems, taking into account every stage in the life of products, from the production of raw material to the "second life" of packaging.

McKinsey: *What does that mean in practice for the way you make products and source materials?*

Emmanuel Faber: To embed the principles of the circular economy in our operations, we have started managing our three key resources—water, milk, and plastic—as cycles rather than as conventional linear supply chains.

One example of this is what we are doing in yogurt. To make Greek yogurt, you use a "strained" technology with a membrane, extracting a lot of acid whey. Instead of just seeing this acid whey as an effluent, we are testing technology solutions in five or six countries and working with different partners to find ways to use whey as a resource. We are

already using whey protein, for instance, in our Early Life Nutrition business, and we will soon be able to use it for animal feed, fertilizers, and energy. What we're doing is turning something that is a challenge today into something that will have value tomorrow.

Under a new partnership with Veolia, a global waste-management company, we are working together on building a circular economy around water and packaging waste, testing new ideas and investigating new technology. One project, for example, aims to optimize recycling techniques so we can build plants with zero liquid discharge.

McKinsey: *What are you doing with plastic waste?*

Emmanuel Faber: At the moment, nearly 30 percent of our total packaging comes from recycled materials, and as much as 80 percent in the case of cartons, but we continue to make progress. For plastics, the endgame could be the creation of a net-positive cycle in partnership with other large companies, which would mean recycling more plastics than we put on the market in the first place.

Plastics are interesting because they highlight an important challenge of a circular economy, namely managing the "hierarchy of degradation." If, say, we allow virgin PET[2] to go into landfills, its reusability potential ends up being low. But if we save it in a closed-loop system, it will continue to be of food-grade quality, good enough to reuse in food packaging. This means it stays at a high level in the hierarchy of degradation. Our ambition is to create a second life for all the plastic packaging we put on the market, so that we move toward 100 percent recycling

Emmanuel Faber

Vital statistics

Born January 22, 1964, in Grenoble, France

Married, with 3 children

Education

Graduated with bachelor's degree in business administration from HEC Paris

Career highlights

Danone Group
(1997–present)

CEO (2014–present)

Vice chairman, board of directors (2011–present)

Deputy general manager (2008–14)

Vice president, Asia–Pacific region (2005–08)

Head of finance, strategies, and information systems (1997–2005)

Legris Industries
(1993–97)

CEO (1996–97)

Chief administrative and financial officer (1993–96)

Fast facts

Director, danone .communities mutual-investment fund (SICAV)

Member, steering committee, Danone Ecosystem Fund

Member, steering committee, Livelihoods Fund

in this respect. Part of the plan is also to launch a 100 percent biosourced second-generation plastic.

McKinsey: *What changes have you made to Danone's organization to reflect the new ways of working?*

Emmanuel Faber: We have created a position in the executive committee in charge of our Strategic Resources Cycles unit. This person oversees separate internal units for the milk cycle, the water cycle, and the plastic cycle. This organizational change has already started to transform the way we work, because it is cross-divisional and cross-functional.

We have also created a Milk Technology Center that reports to the Milk Cycle Organization—part of the Strategic Resources Cycles unit—not to R&D or to the dairy business, as it might under a conventional structure. The aim here is to achieve a step change in our ability to maximize the value of milk and limit the waste from milk production.

McKinsey: *How do you change Danone's culture to embrace circular-economy thinking?*

Emmanuel Faber: Danone has circular-economy principles in its DNA, and people join Danone because of its unique culture and heritage. We do, however, need to continue to create the conditions for new generations to embrace our founding principles of business success and social progress.

The time horizon is critical. You won't start anything if you only think of the next three months; it's got to be something for the next 30 years. At the same time, you need breakthrough objectives. We would never have made as much progress with our CO_2 reduction program in 2008 if we had just gone for a 2 percent reduction per year rather than 30 percent over five years, which we set ourselves. We actually achieved 42 percent.

If you know at the outset how you are going to achieve an objective, you're not aiming high enough to get the organization to start working differently. You have to come up with an objective that is aspirational—something that is too far away to know how it will be reached. That was our intent when we announced, in December last year, that we would target zero net carbon emissions on our full scope of responsibility by 2050.

You also need an investment-payback period that is longer than it is in today's traditional model—five years instead of three; seven years instead of five. For our CO_2 reduction program, we created a special green capital-expenditure category with this in mind. Some bets may have no payback at all. It's about getting a balance between the short, the medium, and the long term.

Incentives are also an important part of the culture because they really show that the leadership team

means what it says. A few years ago, the annual incentive program for the 1,500 top managers at Danone encompassed the CO_2 reduction objective, to the point where, broadly speaking, the yearly bonus attached to CO_2 reduction was equivalent to the yearly bonus attached to profit generation. This is just one example of how we're using incentives to embed our vision across the business.

On top of this, and in order to foster change with Danone's 100,000 employees, the company launched a manifesto to underpin the way we intend to deliver on our mission. This manifesto aims at deepening and enriching Danone's mission, to bring it to the next level of impact, through a series of initiatives across the company and outside it. For instance, a dedicated internal website has been created where people can post ideas and thoughts related to the manifesto and contribute to Danone's journey. To support and coordinate the establishment of the manifesto across Danone's teams and local communities worldwide, the role of chief manifesto catalyst has been created to maximize the potential of this process and catalyze bottom-up innovation.

McKinsey: *How do you think this approach will ultimately benefit Danone, as well as society and the environment?*

Emmanuel Faber: Consumers are interested in what is at work in the products they eat, how these products were produced and delivered, and what their effect is on the body. I believe there is a ladder of brand equity in food. There is a lot attached to the values and culture. Ultimately, the brand should be the link with the consumer and tell the story. ■

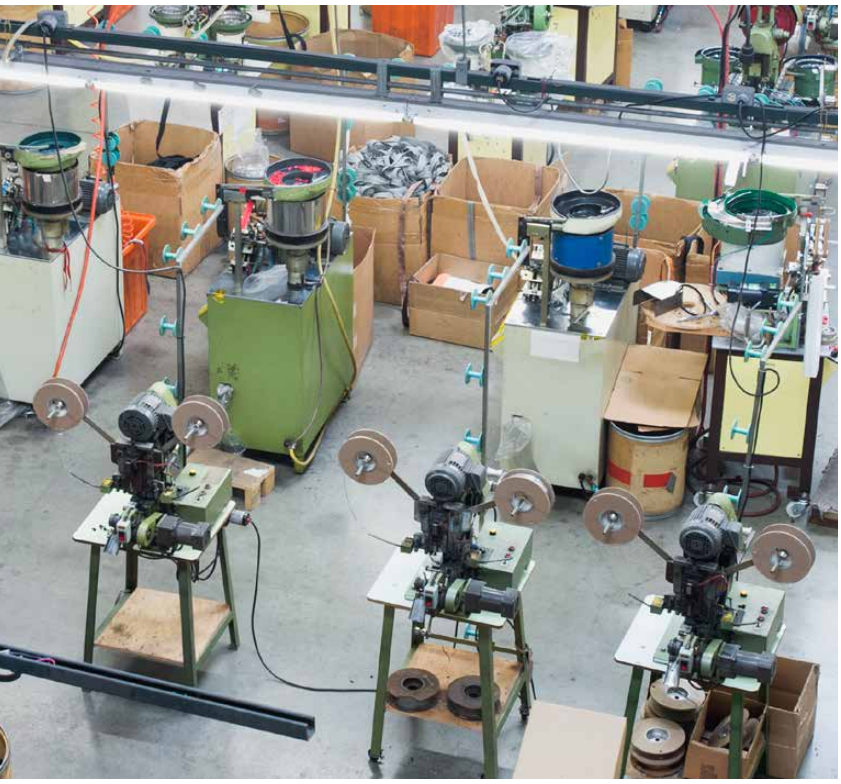
[1] Enterprise resource planning.
[2] Polyethylene terephthalate.

Style that's sustainable: A new fast-fashion formula

Stylish, affordable clothing has been a hit with shoppers. Now companies are trying to reduce its social and environmental costs.

Nathalie Remy, Eveline Speelman, and Steven Swartz

The early 21st century has been good to the apparel industry. Thanks to falling costs, streamlined operations, and rising consumer spending, clothing production doubled from 2000 to 2014, and the number of garments purchased each year by the average consumer increased by 60 percent. Fast fashion has been a particularly hot segment and a source of enviable growth for some clothing companies. By compressing production cycles and turning out up-to-the-minute designs, these businesses have enabled shoppers not only to expand their wardrobes but also to refresh them quickly. Across nearly every apparel category, consumers keep clothing items about half as long as they did 15 years ago. Some estimates suggest that consumers treat the lowest-priced garments as nearly disposable, discarding them after just seven or eight wears.



The fact remains, however, that innovation in the way clothes are made has not kept pace with the acceleration of how they are designed and marketed. Fast fashion is now a large, sophisticated business fed by a fragmented and relatively low-tech production system. This system has outsize environmental effects: making clothes typically requires using a lot of water and chemicals and emitting significant amounts of greenhouse gases. Reports also continue to emerge about clothing-factory workers being underpaid and exposed to unsafe—even deadly—workplace conditions, particularly when handling materials like cotton and leather that require extensive processing. Without improvements in how clothing is made, these issues will grow proportionally as more clothes are produced.

So far, sales increases suggest that most shoppers either overlook or tolerate the social and environmental costs of fast fashion. But some companies aren't waiting for a consumer backlash. They have begun to remedy the largely unseen impact of the fast-fashion business. In this article, we consider how apparel businesses can resolve challenges in two major segments of their value chain: the heavy resource demands and difficult labor issues in the production process, and the excessive waste associated with disposing of unfashionable or worn-out garments.

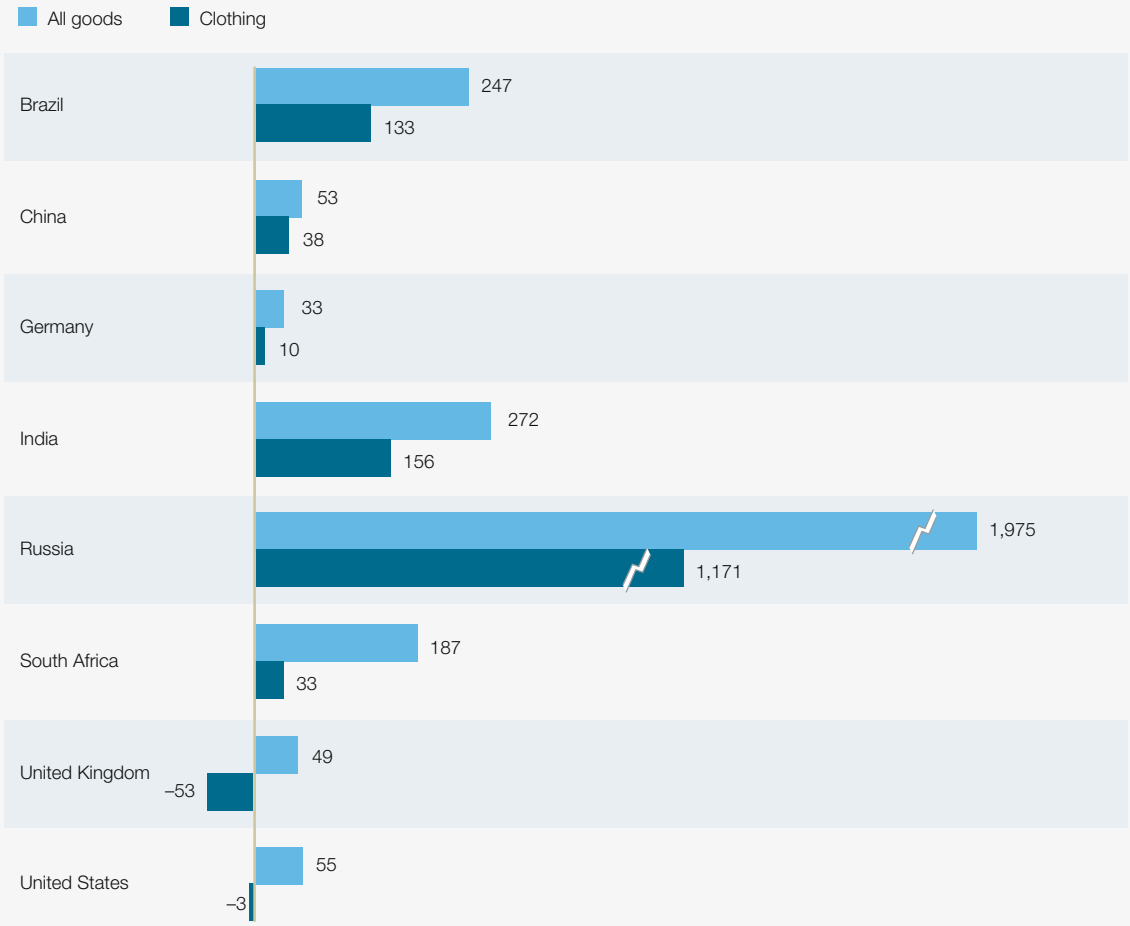
Fast fashion, serious consequences

Apparel sales have risen dramatically in recent years, thanks to several trends that appear likely to continue. Businesses have aggressively cut costs and streamlined their supply chains. This has caused the price of clothing to fall relative to the prices of other consumer goods (Exhibit 1). Shorter lead times for production have also allowed clothing makers to introduce new lines more frequently. Zara offers 24 new clothing collections each year; H&M offers 12 to 16 and refreshes them weekly. Among all European apparel companies, the average number of clothing

Exhibit 1

The slow rise in clothing prices, compared with other consumer goods, has made clothing more affordable.

Change in consumer prices, 1995–2014, %



Source: Euromonitor; McKinsey analysis

collections has more than doubled, from two a year in 2000 to about five a year in 2011.

Shoppers have responded to lower prices and greater variety by buying more items of clothing. The number of garments produced annually has doubled since 2000 and exceeded 100 billion for the first time in 2014: nearly 14 items of clothing for every person on earth. While sales growth has been robust around the world, emerging economies have seen especially large rises in clothing sales, as more people in them have joined the middle class. In five large developing countries—Brazil, China, India, Mexico, and Russia—apparel sales grew eight times faster than in Canada, Germany, the United Kingdom, and the United States.

Even after this increase, the average developing-country resident purchases a fraction of the clothing that his or her developed-world counterpart buys each year. Overall clothing sales could rise significantly if developing-country consumers choose to buy more clothing as their purchasing power increases. We estimate that if 80 percent of the population of emerging economies were to achieve the same clothing-consumption levels as the Western world by 2025, and the apparel industry does not become more environmentally efficient, then the environmental footprint of the apparel industry will become much larger (Exhibit 2).

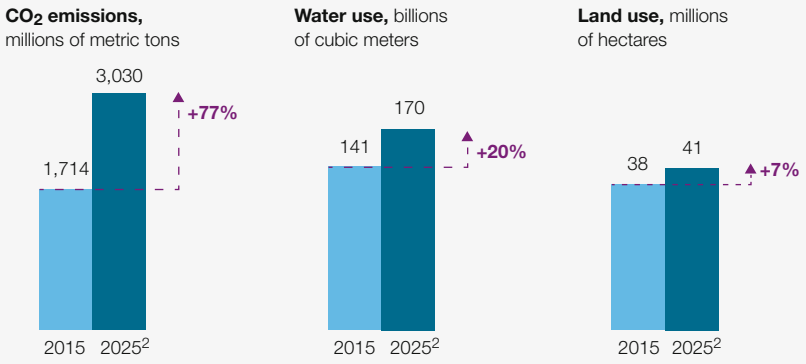
So far, clothing companies have been unable to match their sales gains with commensurate improvements in environmental and social performance. Cotton, accounting for about 30 percent of all textile fiber consumption, is usually grown using a lot of water, pesticides, and fertilizer. Since countries with large fabric- and apparel-making industries rely mainly on fossil fuels for energy production, we estimate that making 1 kilogram of fabric generates an average of 23 kilograms of greenhouse gases.

In addition, many clothing companies face problems with labor conditions throughout their supply chains, including child labor, low wages, and health and safety hazards. Rooting out these problems will require businesses to measure sustainability performance across the entire supply chain, set goals for improvements, help suppliers to reduce their impact, and hold suppliers accountable if they don't.

Exhibit 2

As consumer spending increases, especially in emerging economies, the clothing industry's environmental impact could expand greatly.

Increases in environmental impact if 80% of emerging markets achieve Western per capita consumption levels[1]



[1]Rest of world maintains its current levels of per capita consumption.
[2]Estimated.

Source: World Bank; McKinsey analysis

The sustainability impact of clothing continues to mount after consumers leave the store with newly purchased apparel. Washing and drying 1 kilogram of clothing over its entire life cycle, using typical methods, creates 11 kilograms of greenhouse gases, according to our estimates—an amount that companies could reduce by altering fabrics and clothing designs. The postpurchase choices that consumers make, such as whether to wash clothes in cold, warm, or hot water, also make a big difference.

When it comes to disposing of clothing, current technologies cannot reliably turn unwanted apparel into fibers that could be used to make new goods. Recycling methods such as shredding or chemical digestion work poorly. And there are not markets large enough to absorb the volume of material that would come from recycling clothes. As a result, nearly three-fifths of all clothing produced ends up in incinerators or landfills within a year of being made. Germany outperforms most countries by collecting almost three-quarters of all used clothing, reusing half and recycling one-quarter. Elsewhere, collection rates are far lower: 15 percent in the United States, 12 percent in Japan, and 10 percent in China.

A sustainable design for the fast-fashion value chain

Mitigating the sustainability impact of the fast-fashion business will likely require action across the industry. Some apparel companies have formed coalitions to tackle environmental and social challenges together, which helps to accelerate change and to mitigate the risks of working on these challenges alone. For example, 22 apparel brands belong to a coalition called Zero Discharge of Hazardous Chemicals to improve and expand the use of nontoxic, sustainable chemistry in the textile and footwear supply chain. The Better Cotton Initiative involves more than 50 retailers and brands and nearly 700 suppliers in setting standards for environmental, social, and economic responsibility in cotton production.

A few apparel businesses have begun tackling sustainability challenges on their own. H&M and Levi's have each partnered with I:CO to collect clothing and footwear for reuse and recycling. I:CO provides collection bins, sorts the items so anything wearable can be sold, and recycles what is left. Patagonia not only collects used clothing in its stores and through the mail but also offers repair services so its customers can extend the lives of their garments. And retail chain C&A, recognizing the environmental effects of cotton farming, has launched an effort to purchase only organic cotton by 2020.

We see additional steps that companies can take to remove some of the social and environmental risks that are commonly part of the fast-fashion model:

- Develop standards and practices for designing garments that can be easily reused or recycled. The Sustainable Apparel Coalition has created an index for measuring the full life-cycle impact of clothing and footwear products.
- Invest in the development of new fibers that will lower the environmental effects of production and garment making. In 2016, the Walmart Foundation awarded grants of nearly $3 million to five US universities to support research on improving the sustainability and efficiency of textile manufacturing.
- Encourage consumers to care for their clothes in low-impact ways. Washing garments in hot or warm water and drying at high heat or for longer than needed uses a lot of energy. Clothing makers and retailers can help steer consumers toward clothing-care practices that have a smaller environmental toll and keep garments in good shape for longer.

- Support the development of mechanical- and chemical-recycling technologies. The fibers produced by mechanical recycling, for example, are shorter and lower in quality than virgin fibers and therefore less useful to apparel makers. Chemical recycling could improve on this as the technology advances.

- Establish higher labor and environmental standards for suppliers and set up mechanisms to make supply chains more transparent. For example, the software company EVRYTHNG and packaging maker Avery Dennison have together launched an effort to tag clothing so consumers can trace how individual items were produced all along the supply chain.

- Provide suppliers with guidance and resources for meeting new labor and environmental standards and hold them accountable for performance shortfalls. Walmart, for example, has made a public commitment that by 2017, 70 percent or more of the products it sources directly from suppliers will come from factories with energy-management plans. The company offers its suppliers software tools to help them find opportunities for using energy and other resources more efficiently.

Global demand for clothing looks set to increase significantly over the coming decade, as millions of people in developing countries enter the middle class and spend more on apparel. While this presents a tremendous opportunity for fashion companies, it may be a risky one for companies that choose not to grapple with the social and environmental risks of low-cost, resource-hungry production processes.

Those risks could become even more pressing over time: as the millennial generation gains purchasing power, their high expectations that businesses will operate in a sustainable manner could have a big influence on shopping trends. Production methods that are more sustainable may cost slightly more, but they can also spur innovation and protect businesses from supply-chain shocks and reputation risks, resulting in greater resilience and profitability. ■

Nathalie Remy is a partner in McKinsey's Paris office, **Eveline Speelman** is a consultant in the Amsterdam office, and **Steven Swartz** is a partner in the Southern California office.

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