U.S. CHAMBER OF COMMERCE FOUNDATION
Corporate Citizenship Center

CREATING A CIRCULAR ECONOMY IN THE GREAT LAKES REGION

U.S. CHAMBER OF COMMERCE FOUNDATION AND NAVIGANT – A GUIDEHOUSE COMPANY

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EXECUTIVE SUMMARY

Transitioning from a linear, take-make-dispose economy to a closed loop, zero waste circular economy encourages businesses to design longer lasting, reusable, and more easily recyclable products. This evolution can also result in the expansion of reuse and remanufacturing sectors as well as new value chains and markets. While engagement in the circular economy is becoming commonplace in Europe, more evidence and support are needed to build and illustrate the North American business case, along with practical steps and actions to mainstream circularity.

This report by Navigant – A Guidehouse Company and its research partner, the U.S. Chamber of Commerce Foundation, describes the economic and environmental benefits and winning strategies for businesses to put the circular economy into practice in the Great Lakes and St. Lawrence Region (GLR).[1] In particular, the quantitative research in this report focuses on three core materials—steel, plastics, and pulp and paper—that extrapolate from European trends to predict outcomes and economic and environmental opportunities of the circular economy in the GLR. Case studies of experiences and best practices from companies showcase the circular ingenuity transforming North American business.

Results demonstrate vast economic and environmental benefits for adopting a circular economy in the GLR. Among the three materials studied, the economic benefits range between $4.4 billion to $5 billion USD. The environmental benefits are equally advantageous, with reductions in greenhouse gas emissions ranging from 35 million to 120 million tons of carbon dioxide equivalent (tCO_2). This reduction would be equivalent to removing 7.5 million to 25.5 million passenger cars from the road for a year, which translates to 18%-61% of registered cars in the GLR.[2,3]

The report's findings also reveal the importance of developing incentives that facilitate innovation and greening of the value chain, encouraging partnerships and collaboration to foster circularity, aligning the circular economy with mainstream policies, developing traceable actions and targets that hold stakeholders accountable for their progress, and embracing the social aspects of circularity to implement measures to support this shift. With these tactics in place, businesses in the GLR and beyond can achieve profound economic and social impact through the circular economy.

INTRODUCTION

For centuries, the predominant growth model for economies and businesses has been based on the extraction and manipulation of finite resources to create products. Disposal is often the result when these products have served their purpose and reached the end of their life cycle. While this linear growth model has enabled societies to prosper, rapid population and economic growth have greatly increased the demand for goods and strained supplies of all resources. These trends are forcing businesses to reconsider the utility of the traditional growth model and explore new ways to spur economic advancement.

One economic model that has gained traction is the circular economy. Also referred to as a closed loop system, a circular economy reuses and recycles materials, water, and energy involved in production processes with the goal to find other uses for waste and byproducts. This approach views waste from products or production processes as a source of cost reduction or a potential revenue stream. At its essence, the circular economy minimizes waste and maximizes the utilization of resources.

Companies and governments are embracing the circular economy as a viable approach to decouple economic growth from resource constraints. Additionally, they are promoting this model to realize new opportunities to enhance performance, eliminate waste, drive greater resource productivity improvements, and contribute to a stronger, competitive economy. In Baltimore, for example the City Department of Recreation and Parks united with the city's Office of Sustainability to create Camp Small Zero Waste. Camp Small Zero Waste is a wood waste collection yard where city crews and contractors bring logs, chips, and brush for processing. With Camp Small Zero Waste, wood products at the site are sorted and distributed for resale to Baltimore residents and businesses for landscaping and other needs.[4]

The data that drive these entities to adopt a circular model are compelling. Since 1980, the annual rate of material extraction has tripled, fueled by increases in demand for their consumption.[5] Forty billion tons of natural resources will be used annually through 2050 despite improvements in the efficiency of resources and technology.[6] Prices for several key commodities have also increased nearly 150% between 2002 and 2010—nullifying price declines from the last century—and have continued to escalate.[7] Given these trends, the businesses and governments that mitigate their risk through the recovery and reuse of materials and adaptions in supply chains stand to obtain a greater economic advantage.

The Great Lakes Region and the Circular Economy

Like other regions, the Great Lakes and St. Lawrence Region (GLR) endeavors to become more circular and is making a strong case for its leadership in the space. An average of 365 pounds of recyclables are collected per household per year in the GLR.[8] However, as in almost all regions, challenges exist to achieve a thriving circular economy. Eighty-one percent of waste is still sent to landfills, and roughly 10,000 metric tons per year of plastic pollution enters the Great Lakes.[9,10]

To examine circular efforts and support the region's transition to a circular economy, one study assessed the state of waste streams of several cities in the GLR to identify how certain materials have been inefficiently diverted in the system.[11] Across the four cities analyzed (Toronto, Ontario; Hamilton, Ontario; Chicago; and Cleveland), 60% of waste was created by industry, while the other 40% was generated by households. The main types of waste generated by the four focus cities were paper, plastics, and organics (e.g., food, leaves, and grass clippings), which were also the primary materials sent to landfills. Chicago (52%), Hamilton (45%), and Toronto (45%) divert similar rates of total waste to recycling and circular uses, while Cleveland diverts 30% of its waste.

Fostering a circular economy by augmenting diversion rates can provide both economic and environmental benefits to cities, states, and provinces in the region. A study by the Ontario Waste Management Association in Canada estimates that increasing the province's waste diversion rate from the current 23% to 60% would create nearly 13,000 new direct and indirect full-time jobs and boost the province's gross domestic product (GDP) to $1.5 billion CAD.[12] From an environmental perspective, Ontario's material reuse and recycling programs could also reduce greenhouse gas (GHG) emissions by 14.5 metric tons of carbon dioxide equivalent per year—equal to almost 9% of Ontario's total GHG emissions in 2014.[13]

Research by Accenture, and refined by the World Business Council for Sustainable Development, establishes five key business models of the circular economy that served as a guide for this report:

- **Circular value chain:** Designing products and assets with low-footprint material selection and minimized resource use throughout the life cycle.
- **Lifetime extension:** Extending the lifetime of products and assets through a greater focus on maintenance, upgrade, and repair, as well as reverse logistics, product take back, and remanufacturing.
- **Recovery and reuse:** Recovering and treating wastes and byproducts for reuse as inputs or cascading for other uses.
- **Service models:** Offering products as a service through pay-per-use models and employing sharing and leasing platforms to maximize utilization of products and assets.
- **Digital platforms:** Dematerializing by replacing physical services with online equivalents and using the Internet of Things to optimize resource use and maximize value.

These models can shape strategy on how to integrate the circular economy into business processes.

Source: Accenture Strategy, *Circular Advantage*, Dublin, Ireland, 2014.
https://www.accenture.com/us-en/insight- circular-advantage-innovative-business- models-value-growth%20

In addition to diverting materials and improving energy and water efficiencies during production, government policies can advance a circular agenda. The 2016 Waste-Free Ontario Act enacted in the province of Ontario, Canada, includes two separate policies: the Resource Recovery and the Circular Economy Act (RRCEA) and the Waste Diversion Transition Act. The goal of the RRCEA is to encourage resource recovery and reduce waste to the landfill and identify responsibility for collection and management of products with regard to their reuse, recovery, or recycling. The Waste Diversion Transition Act promotes the process for reuse and/or recycling of electrical and electronic equipment.

Although the U.S. does not have specific laws or policies addressing the circular economy or facilitating its implementation, there are federal and GLR initiatives to environmentally protect and restore the area. For example, the U.S. National Oceanic and Atmospheric Administration's (NOAA's) Great Lakes Land-Based Marine Debris Action Plan (2014–2019) is a collaboration of the public, private, and nonprofit sectors to identify gaps in knowledge, guide policy and management decisions, and reduce debris in the Great Lakes.[14]

Research

Identifying economic and environmental value is key to fully transitioning to the circular economy. Such analyses can provide GLR businesses and other stakeholders with an accessible and meaningful way to quantify, capture, and communicate their value to accelerate the circular economy transition in the GLR.

To meet this need, this report, created by the by Navigant and the U.S. Chamber of Commerce Foundation, highlights the economic and environmental value of the circular economy in the GLR. By tracking the potential impact through available and forecast data, the report showcases how companies operating in specific sectors can translate circular opportunities into business best practices that unlock new growth, competitiveness, and innovation. This assessment provides a high-level overview of the potential benefits of a circular economy for the region considering three key materials: steel, plastic, and pulp and paper. Case studies of the circular economy practices related to these materials further highlight the breadth and depth of businesses' innovation and commitment to this movement.

ASSESSING THE ECONOMIC AND ENVIRONMENTAL POTENTIAL OF THE CIRCULAR ECONOMY IN THE GREAT LAKES REGION

For the quantitative analysis in this report, a total of nine potential circular economy measures across three materials—steel, plastic, and pulp and paper—were considered.[15] These materials were chosen based on data availability and relevance to the GLR in terms of manufacturing and contribution to regional GDP.[16, 17] Based on preexisting studies and frameworks, the relevant circular economy potential in the European Union (EU) was scaled to the GLR using baseline data specific to the region.[18] The measures indicate the economic or environmental potential that could be achieved under a more circular economy—in dollar savings and/or emissions reductions—by 2050 in the GLR. They are categorized based on the level of ambition to show different opportunities for the GLR under two scenarios: the Partial Circularity Scenario and the Ambitious Circularity Scenario. In both scenarios, the figures presented are the estimated potentials for the selected measures.

The rationale for considering two different ambition scenarios is that some measures are more challenging and costly to implement than others, so their viability in the economy will depend on a broad array of political and technological factors that go beyond market viability. Table 1 summarizes the list of measures, the associated estimated savings potential in terms of dollar savings (economic) or emissions reductions (environmental), and the scenario groupings. Figures 1 and 2 highlight the economic and environmental savings potential for the GLR under the two scenarios by 2050. Since not all measures have quantifiable economic savings, the difference between the Partial and Ambitious Scenarios in Figure 2 is not as great as in Figure 1.

Achieving either the ambitious or partial circularity scenarios depends highly on regulatory incentives and structures, developments in infrastructure, industry setup, and future costs of materials and waste management, which have not been factored into these calculations. Other circular measures, such as digitalization and the sharing economy, could also bring savings and benefits to the society but are not estimated due to the lack of data.

Table 1. Summary of the circular economy measures for the GLR

Material	Circular Economy Measure	Economic savings	Environmental savings	Partial Circularity Scenario	Ambitious Circularity Scenario
Steel	Reducing loss of scrap	✓	✓	✓	✓
	Increasing material circularity for steel		✓	✓	✓
	Increasing material circularity by managing copper levels		✓		✓
	Increasing product circularity for steel		✓		✓
Plastic	Increasing mechanical recycling	✓	✓	✓	✓
	Increasing chemical recycling	✓	✓		✓
	Deepening transformation		✓		✓
Pulp and Paper	Using lignin as a functional product	✓	✓	✓	✓
	Optimizing process waste streams	✓	✓		✓

Figure 1. Environmental savings potential of two the circular economy scenarios in the GLR in 2050

Source: Navigant calculation

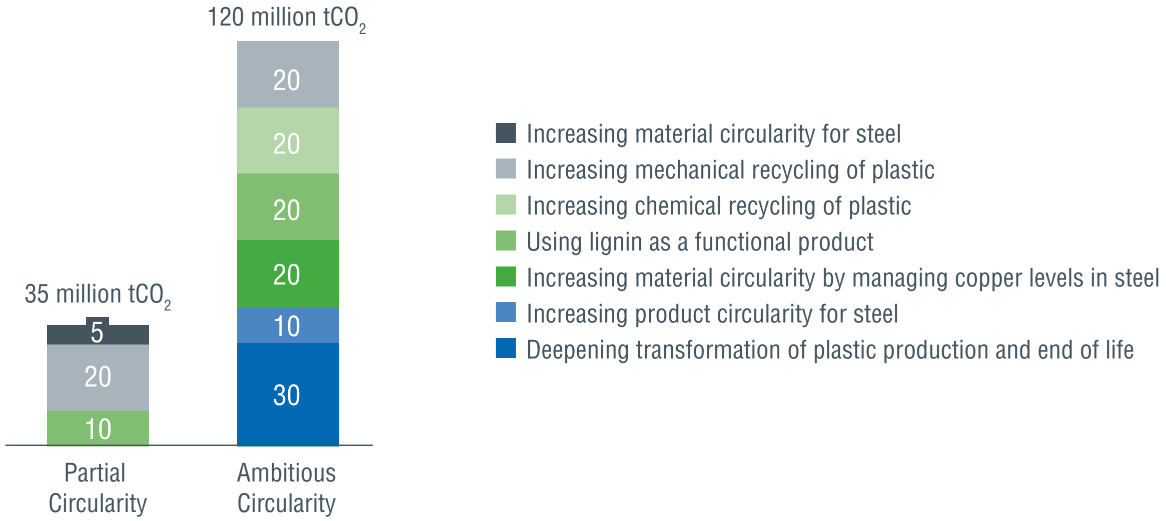
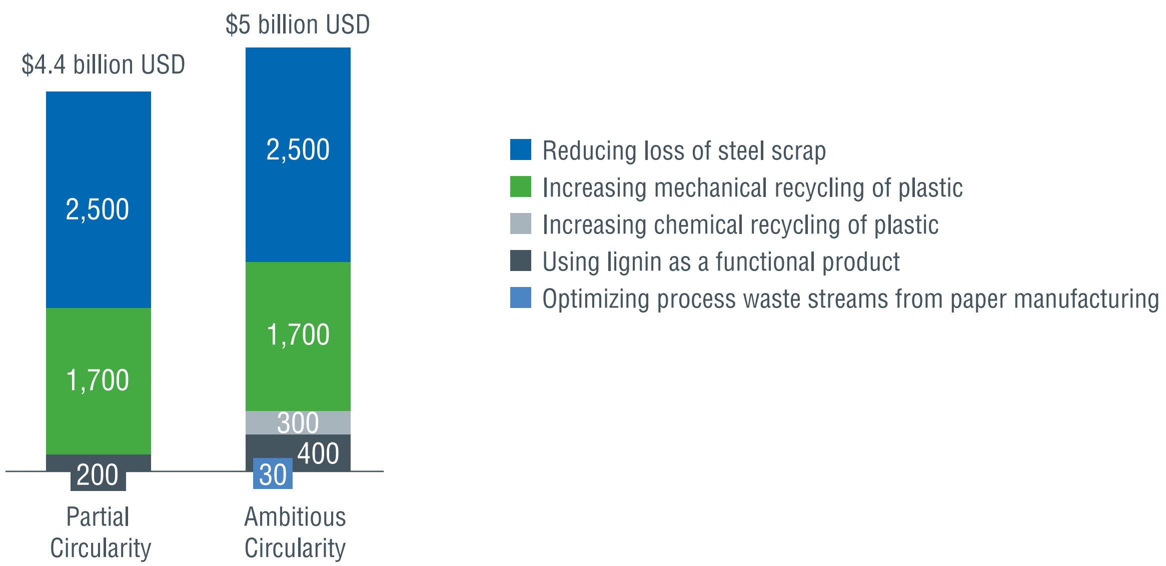


Figure 2. Economic savings potential of the two circular economy scenarios in the GLR in 2050 (in million USD)

Source: Navigant calculation



Steel

Shifting from primary to secondary steel is a core part of circularity for steel, which is reflected in all four circular measures. Primary steel is made by converting liquid iron and steel scrap into steel. Secondary steel is refined crude steel (processes include alloy addition and homogenization, among others) that entails less carbon-intensive production than primary steel.[19] Economic and environmental savings are calculated based on actual steel production data and the recycling rate in the GLR with global averages of emissions intensities for primary and secondary steel production, steel production growth rate, cost of steel production, and effectiveness of copper contamination management.[20] The Schnitzer case study, on page 23, also highlights the role manufacturers have in recycling and repurposing steel and the maintenance of a strong market for secondary steel.

Reducing loss of scrap will have an economic potential of over $2 billion USD by 2050.

Partial Circularity Scenario

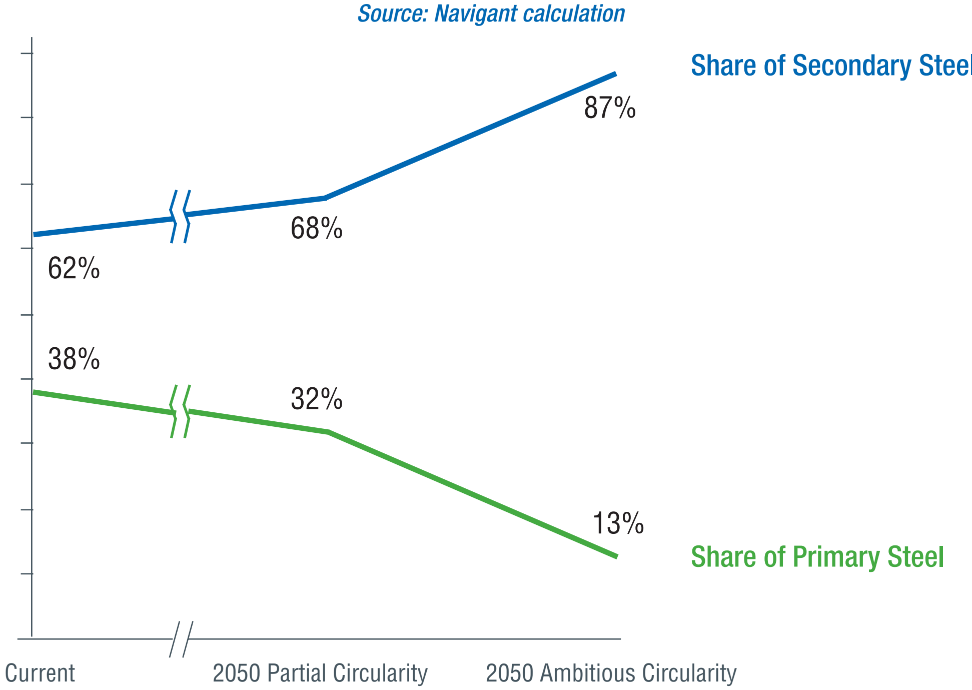
Currently, the global steel sector loses 9% of scrap throughout the value chain each year.[21] Reducing this loss of scrap could be achieved by eliminating obsolete stock, improving scrap collection rates, and reducing new and old scrap loss from fabrication and end of life. Given the expected steel production in the GLR by 2050, about 5 million tonnes of primary steel production could be avoided by increasing the availability of quality secondary steel by reducing the loss of scrap, equivalent to over $2 billion USD in economic savings. [22, 23, 24] Material circularity of steel could be improved through better collection of end of use products, the forming of new scrap, and reducing remelting losses. While the GLR already has a relatively low share of primary steel in its current production (38%), improving circularity could further decrease the share of primary steel to 32% and increase secondary steel to 68% by 2050 (see Figure 3).[25, 26]

Ambitious Circularity Scenario

Additional material circularity through copper-level management could further reduce the

Figure 3. Share of primary and secondary steel in the GLR

Source: Navigant calculation



share of primary steel in production in the GLR to 13% by 2050. Copper is typically added to steel at the point of recycling, and once added, it cannot be removed.[27] Certain applications for steel can tolerate a higher share of copper, but copper levels in steel scrap already exceed the tolerances for many key products in Organisation for Economic Co-operation and Development (OECD) countries.[28] Ensuring that copper contamination remains below tolerance levels involves boosting product dismantling processes at end of life, improving sorting whereby high copper scrap is separated from purer scrap and design improvements that make it easier to avoid cross-contamination of materials during recycling.[29] Otherwise, scrap with high levels of copper need to be diluted with primary steel.

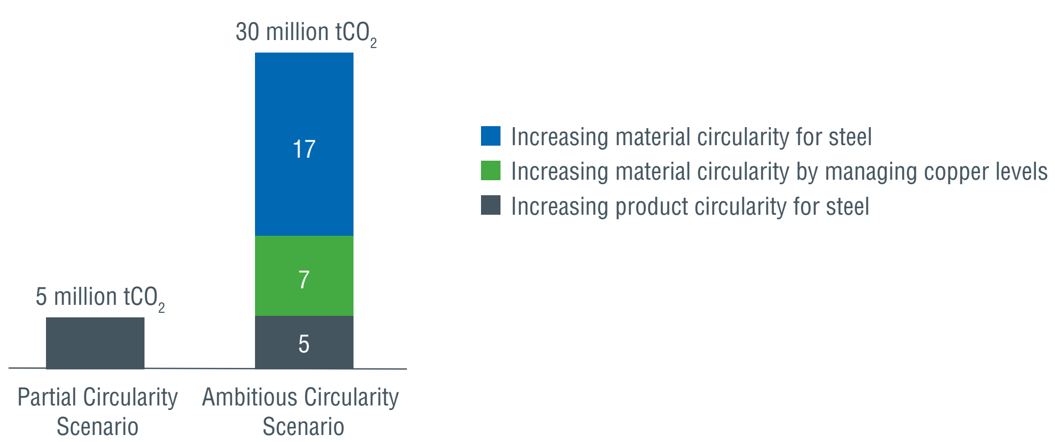
By 2050, the demand for primary steel to make second steel usable in more industrial uses—could amount to as much as 100 million —150 million tonnes per year globally.[30] To reach 87% of steel production being secondary steel, copper management would help significantly lower the emissions of steel manufacturing in the region. However, until steel contamination is better managed, there is a missed opportunity. As noted by Kohler (see text box on next page), incorporating recycled steel from post-consumer waste remains a challenge due to a higher risk of copper contamination (among other contaminants like chrome, tin, manganese, lead, and mercury). Achieving deep cuts on the supply side alone would require extraordinarily rapid, global implementation of processes for steelmaking that are still unproven at scale. Demand-side policies are also essential to move towards the circular scenario for steel in 2050 to materialize the emissions reductions through reducing the need for primary steel.[31]

Product circularity for steel could reduce the emissions of the material by focusing on increased sharing, longer life spans of products, more intensive use, and light weighting.[32] The assessment for the EU estimated that the sector's emissions could be reduced through product circularity in the transport and building sectors at the rate of 0.15 tCO_2/tonne steel produced in 2050.[33]

Steel Summary

If the current business as usual continues to 2050, the region will see an estimated 40 million tCO_2 of emissions based on the expected steel production in the GLR by 2050.[34, 35, 36] In the Partial Circularity Scenario, emissions would be roughly 35 million tCO_2, implying roughly 5 million tCO_2 emissions savings (see Figure 4). In the Ambitious Circularity Scenario, emissions would be more drastically restricted to around 10 million tCO_2, resulting in 30 million tCO_2 in savings.

Figure 4. Environmental savings potential of circular measures for steel in the GLR in 2050 in Partial Circularity and Ambitious Circularity Scenarios



KOHLER AND CONTAMINATION IN THE SECONDARY STEEL MARKET

Kohler produces three different types of cast iron products:

- Ductile iron for Kohler Industrial Castings, such as crankshafts, torque converters, and railroad car components.
- Gray iron for Kohler engine iron, including flywheels, housings, and pump bodies.
- Kohler enameled cast iron used for glass enameled kitchen sinks, bathtubs, bathroom sinks, and shower trays.

The final cast iron products are created from a combination of iron sources—50% Kohler reclaimed materials from process waste such as pouring sprues and gating systems as well as rejected products, 30%–35% recycled steel scrap, 15% virgin "pig" iron, and about 5% alloy products (e.g., silicon, copper, phosphorus, and manganese) to balance the chemistry of the iron batch.

There are two main streams of recycled steel content from external sources available to Kohler:

- Post-industrial waste: factory byproducts, such as offcuts from stamping and forming manufacturing processes.
- Post-consumer waste: taken from consumer recycle streams, such as washing machines, radiators, and other scrap products.

Kohler purchases scrap steel through Wisconsin scrap brokers located in Milwaukee, Fond du Lac, and West Bend. All purchased steel scrap is sourced from post-industrial waste. Post-consumer waste is not reliable because of the higher risk of contamination. Problematic contaminants include chrome, tin, manganese, copper, lead, and mercury. For this reason, Kohler has established strict protocols to minimize the risks of contamination.

All new sources of recycled content (through brokers) are held to documented material specifications that include the amount and types of contaminants allowable, as well as sizing, moisture, and other physical contaminants. The brokers are responsible for ensuring that specifications are met through managing the protocols and verifying each supplier. Kohler tests all new streams of materials, and performs random incoming material checks. If contamination is found during production, Kohler will dilute batches with virgin "pig" iron to bring the batch back to the necessary requirements. If this is not successful, the materials are returned to the supplier.

Plastic

Continued growth is predicted in the global plastic sector due to mounting consumption of consumer goods in developing economies. By the end of the century, it is estimated that plastics consumption will increase 300%.[37] Enhanced recycling—both in scale and in scope—and circular business models associated with plastic are core to augmenting the circularity of plastics.[38] The circular potential of plastics in the GLR is estimated based on plastic production and the recycling rate in the region, together with assumptions on emissions intensities of different recycling or end-use streams, the potential of mechanical and chemical recycling, and the share of secondary plastic used in production.[39, 40]

Partial Circularity Scenario

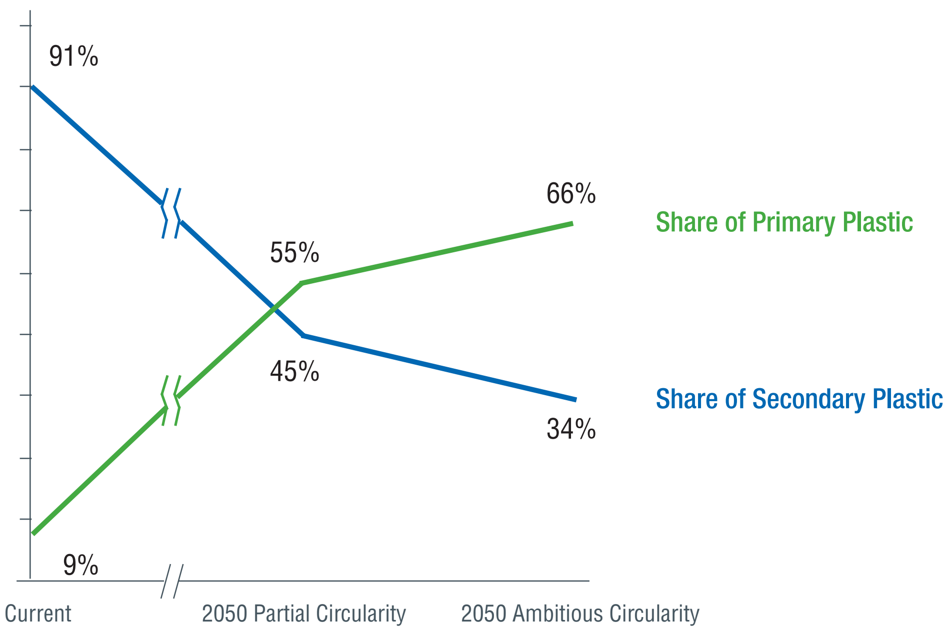
Increasing mechanical recycling of plastics through higher collection rates and yields could help reduce the need for virgin material of plastics and therefore lifetime emissions for the value chain.[41] The current recycling rate for plastics in the GLR is roughly 9% and is dominated by mechanical recycling given the current technology, infrastructure, and cost.[42, 43] A study estimated that 56% of the five largest plastic types (i.e., polyethylene (PE), polystyrene (PS), polypropylene (PP), polyvinyl chloride (PVC), and polyethylene terephthalate (PET)) could be mechanically recycled in the EU through improving the collection and sorting systems.[44] According to the Material Economics framework, it is assumed that the mechanical collection rate can increase to 73% with the recycling yield improved to 76%.[45] With these rates, the region could see increases in the share of secondary plastic up to 66% by 2050 (see Figure 5).[46] If all the recycled plastics could replace the virgin plastic production, the lower life-cycle emissions of recycled plastics could lead to over 20 million tCO_2 emissions reduction in the GLR by 2050.[47] The sector could also potentially see economic savings from the lower cost of recycling and greater revenues from selling recycled plastics by 2050.[48]

Ambitious Circularity Scenario

Increasing chemical recycling to capture the remaining plastic waste could further enhance the circularity of the material.[49]

Figure 5. Share of primary and secondary plastic in the GLR[52]

Source: Navigant calculation



The economic potential for increased recycling of plastic—both mechanically and chemically—will be nearly $2 billion USD by 2050, assuming significant reductions in the cost of recycling and higher revenues from selling recycled plastics.

Unlike mechanical recycling, which does not change the basic structure of the material, chemical recycling of plastic waste involves converting it into feedstock (i.e., monomers, oligomers, and higher hydrocarbons) that can be used to produce virgin-like polymers to create new plastic articles. The process of chemical recycling results in CO_2 emissions, but it eliminates embedded and production emissions that would arise from the use of new fossil feedstocks for plastic production. Although it has a higher life-cycle emissions intensity than mechanical recycling, it is still lower than the emissions from producing virgin plastics with technology improvements that will continue to 2050.[50] One study indicates the potential to ramp up chemical recycling for plastics to cover 11% of the total plastic waste stream.[51] This could result in nearly 20 million tCO_2 of emissions reduction in the GLR by 2050, at which point the lower cost and higher revenue from recycling could also bring economic savings.

Deepening transformation of plastic production and waste management offers additional savings, but it requires innovation

and a shift to reuse and recycling becoming the standard. Specifically, this transformation can be achieved through additional recycling, substitution with other materials, renewable energy use in production, bio-based on CO_2 feedstock, and process innovation. These measures would require an ambitious level of innovation and changes in business operations and technology uptake to occur throughout the value chain. Currently, there is a lack of comprehensive assessment of the extent of the benefits these types of recycling could materialize. The Material Economics framework provided an indicative estimate of potential additional emissions reductions for plastic, which is applied to the GLR based on expected plastic demand and emissions reduction intensity.

While the potential environmental savings from these deeper transformation measures could be significant—over 30 million tCO_2 for the region—these would require formidable investment in waste management infrastructure, production process, and technology development. Furthermore, barriers to curbing the associated waste and emissions are apparent at each stage of the plastic value chain: in raw materials production, product design, collection, end-of-life treatment, recycling, and the secondary materials market.

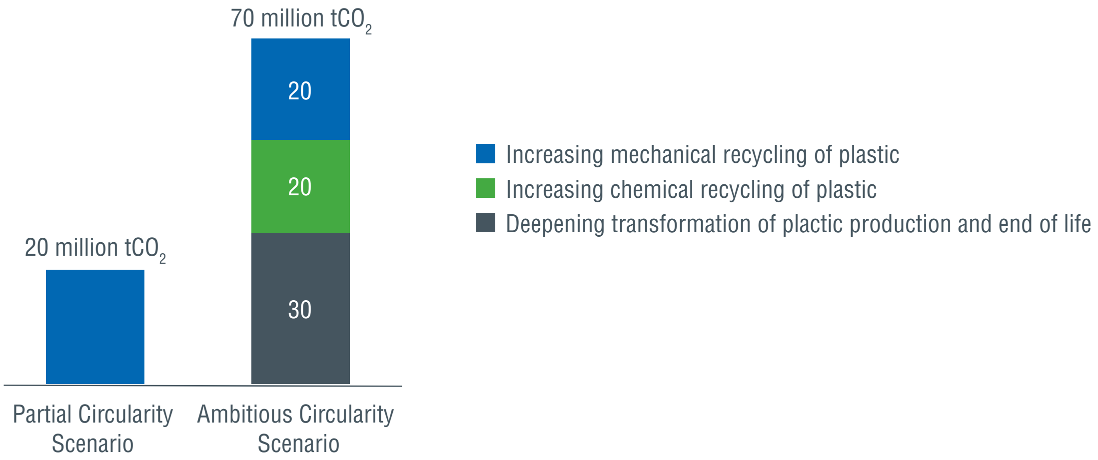
The most critical factors and policies that will influence trends in plastic production and circularity will revolve around designing products for recycling. In this vein, the Procter & Gamble How2Recycle case study discusses how the company's journey to enable a more circular model began by redesigning packaging to be recyclable in existing recycling streams. Similarly, the Kohler Redesigning Engines for Circularity case study highlights how following the company's Design for Environment principles aligns with circular economy principles.

Plastic Summary

If current conditions continue to 2050, the region will see an estimated 80 million tCO_2 of emissions based on the expected demand for plastic in the GLR. In the Partial Circularity Scenario, emissions would be roughly 60 million tCO_2, implying 20 million tCO_2 emissions savings. In the Ambitious Circularity Scenario, emissions would be more drastically restricted to around 10 million tCO_2, resulting in 70 million tCO_2 in savings (see Figure 6).

Figure 6. Environmental savings potential of circular measures for plastic in the GLR in 2050 in Partial Circularity and Ambitious Circularity Scenarios

Source: Navigant calculation



Pulp and Paper

Paper is one of the most recycled materials in the U.S. As will be noted in pages 15, 22, and 27, the pulp and paper sector is recognized for its ongoing effort to enhance recycling throughout all aspects of the industry.

The sector has been optimizing resource efficiency in production process and improving product design to unlock further recycling potential. The savings measures for pulp and paper relate to using byproducts and waste streams from wood and paper product manufacturing rather than the reuse and recycling of paper itself, also highlighted in the case studies. Economic savings are calculated using the economic potential for use of byproducts (in this case, using lignin—a material in wood that can be substituted for fossil-based materials in end products—as one example of byproduct use) and the economic potential for waste streams of wood and paper product manufacturing. Further, since lignin can be substituted for other materials with higher emissions intensities, research was conducted to determine the input ratio of lignin for mid- and high-value substitution products, as well as the global warming potentials of the lignin-based mid- and high-value products and the fossil-based mid- and high-value products to estimate potential environmental savings.

Partial Circularity Scenario

Using lignin as a functional product could provide substantive environmental and economic savings to the GLR. Raw wood contains about 30% lignin, and it is assumed that the share of lignin that can be input into functional products in the GLR is 25%.[53, 54, 55, 56, 57] For this measure, two end products—one of mid-value, bio-based adhesive and one of high-value, food chemicals/bio-based adipic acid—were selected for lignin to substitute its fossil-based components. As stated, the assumption is that 25% of the lignin available in the GLR can be used for functional products, in which 60% can be used for mid- and high-value products.[58] For the Partial Circularity Scenario, it is assumed

that only half of the lignin available for high- and mid-value applications (half of 60% of 25%, so 7.5%) can be used, potentially reducing emissions by over 10 million tCO_2 by 2050.

Ambitious Circularity Scenario

In this scenario, the full 60% of 25% (15% total) of the lignin available for high- and mid-value applications can be used in the Ambitious Circularity Scenario, reducing over 20 million tCO_2 by 2050.

Using lignin as a functional product has the potential to save over 20 million tCO_2 by 2050 under the Ambitious Circularity Scenario.

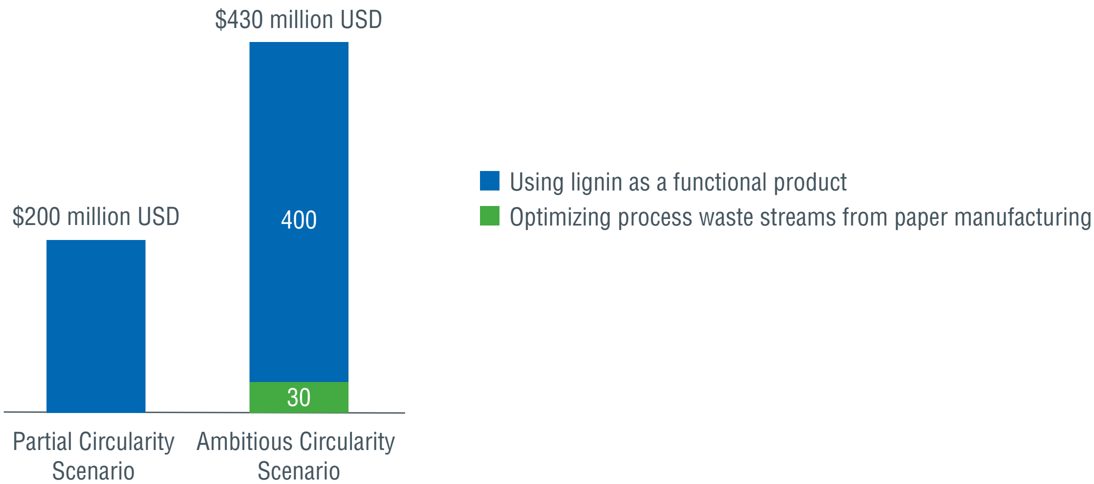
In addition, optimizing process waste streams that occur during paper making, including sludge, ash, and other industry waste, can unlock substantial economic potential in the GLR if they are used as potential energy sources or in fertilizers. For this measure, it is assumed that all process waste streams currently landfilled will be used and that changes in regulations and technology will make ash and other waste valuable inputs to production.

Pulp and Paper Summary

Either the ambitious or the partial circularity scenarios could generate additional economic savings from the sales of lignin products at over $400 million USD in the GLR by 2050 (see Figure 7).[59]

Figure 7. Economic savings potential of circular measures for pulp and paper in the GLR in 2050 in the Partial Circularity and Ambitious Circularity Scenarios

Source: Navigant calculation



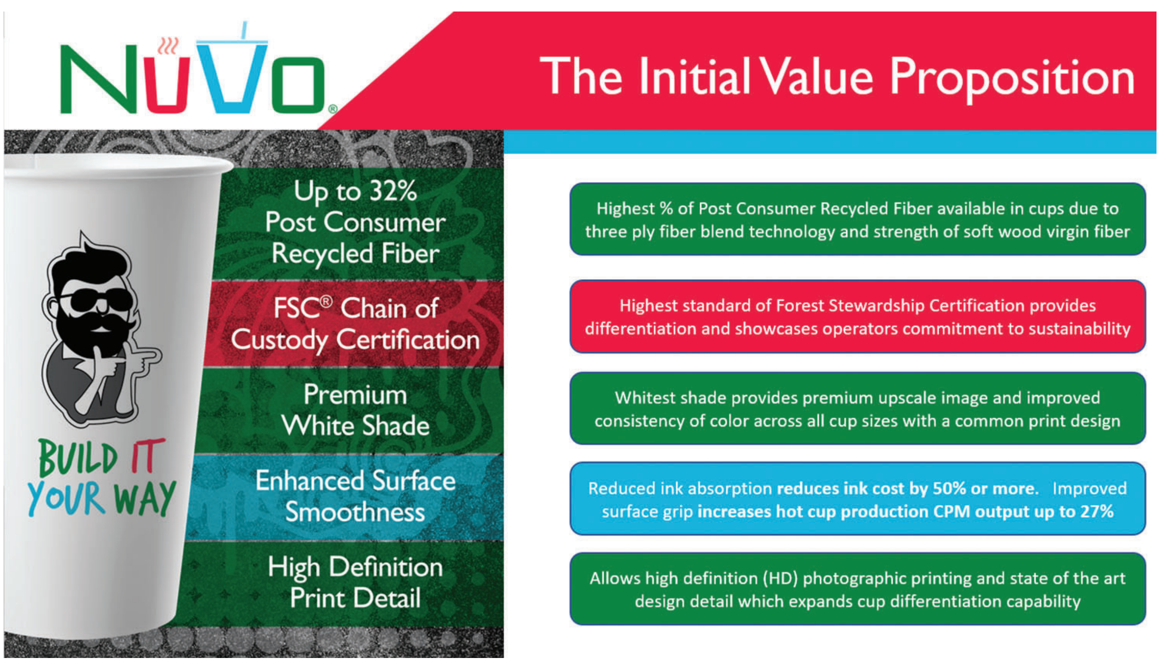
CASE STUDIES

CLEARWATER PAPER'S NUVO® CUP STOCK: ACHIEVING IMPROVED SUSTAINABILITY THROUGH BALANCED DESIGN

In 2017, Clearwater Paper evaluated an upgrade to the performance and sustainability of its cup stock paperboard produced at the Lewiston, Idaho, mill. Using a stage gate process, Clearwater Paper determined there were opportunities to better meet the needs of the next generation of consumers while producing a superior performing product for its converter customers. In fact, the company identified multiple improvement opportunities, and as a result, created a fresh brand to better represent the new capabilities. On March 25, 2019, Clearwater Paper launched NuVo® with increased levels of post-consumer recycled fiber content, also featuring the Forest Stewardship Council chain of custody certification. The print surface allows for enhanced graphic design capabilities with reduced ink usage. NuVo's brand features combine multiple sustainability values, strengthening the company's circular value chain. The graphic below provides a list of the brand's attributes.

One of the key sustainability gaps the company identified was a lack of post-consumer recycled fiber (PCF) cup stock in the market. Clearwater Paper identified three reasons for the reduced use of PCF: fiber cost, cup forming performance, and paperboard color/shade.

The cup forming process stresses the paperboard, and a balance of strength, stretch, and flexibility is needed to form a tight cup rim and bottom, especially at high forming speeds. PCF does not have the strength and stretch characteristics of the longer, unprocessed virgin softwood fiber. Most paperboard machines in North America make a single ply paperboard sheet. On single ply machines, it is difficult to direct distribution of different fiber types. Higher concentrations of PCF blended into a single ply may weaken the cup stock performance, which can cause cup forming issues that result in downtime or reduced forming speeds. There is a limit to PCF fiber



content in cup stock. Virgin fiber is needed to balance performance.

The Clearwater Paper paperboard machine in Lewiston, Idaho, is a multi-ply machine that provides a platform to customize fiber blend stratification. The company addressed the potential performance gap of high PCF content by using virgin softwood on the outside layers and positioning the weaker PCF strategically to optimize strength and performance. To increase PCF content up to 32%, the company customized its fiber blend to optimize performance on a cup machine. Clearwater Paper commercialized up to 32% PCF in NuVo® after reviewing the data from numerous forming trials on a variety of cup forming machines. The company addressed the PCF cup shade concerns using the same blending strategy. The biggest gap was offsetting the higher cost of the PCF. If the company makes a sustainable product affordable, it has the capability of driving volume scale, which drives the environmental impact. The enhanced surface coating reduces ink usage by 50% or more, which helps offset the cost of the PCF. Clearwater Paper discovered that the enhanced surface improves cup forming speeds during its trials. Those trials showed cup per minute forming improvement up to 27%. Along with cost savings from ink use reduction, increasing cups per minute provides a significant potential lever to offset the cost of PCF.

A new generation of consumers wants to see a higher percentage of recycled content. Clearwater Paper believes that improving the sustainable attributes and performance of its cup stock drives material differentiation and choice, which is attractive to foodservice operators that want to tell a unique story about their brands and beverage packaging.

The development of NuVo® has had a positive impact on the pulp and paperboard operations team in Lewiston. The team is energized about working on cup development, which fuels the mill's ability to succeed in the future. The long-term goal for NuVo® is to provide the largest variety of cup stock material choices and capabilities to drive improved cup sustainability, cost reduction, and performance. Build It Your Way is the company's NuVo® motto—or simply, Evolution Revolution.

CASE STUDIES

DOW: USING RECYCLED PLASTICS TO PAVE ROADS AND PARKING LOTS IN MICHIGAN

Advancing the circular economy is a pillar of Dow's 2025 Sustainability Goals, and the company is on a relentless pursuit of solutions. One area of focus for these solutions is used plastics. As the world's largest producer of polyethylene—a key ingredient used to create high-quality plastics—Dow recognizes its responsibility and opportunity to minimize plastic lost to the environment and maximize its potential as a reusable resource.

Only 9% of the 9 billion–10 billion tons of plastic generated since 1950 has been recycled. Curbing this trend is an ambitious undertaking: there is no silver bullet, and this isn't a one-company or one-government issue. That's why Dow works with many partners on a variety of projects designed to advance the circular economy and minimize plastic waste. Such projects include creating recyclable packaging for applications, for which recyclability was previously impossible, and partnering with organizations to build waste management infrastructure.

In the Great Lakes Bay Region in Michigan, Dow and its project partners used recycled plastics to modify asphalt for roads and parking lots. How? Through Dow's ELVALOY™ asphalt modification technology and the unique contributions the partnering organizations brought to the collaboration to utilize recycled plastic modified asphalt (RPMA).

For the Michigan project, Dow used more than 10,400 pounds of recycled plastics—equivalent in weight to more than 769,500 plastic grocery bags—and covered 5.5 lane miles of asphalt roads and 30,500 square yards of parking surfaces. When combined with a similar project in Freeport, Texas, Dow's RPMA paving projects in North America have incorporated more than 12,086 pounds of plastic, equivalent in weight to approximately 889,500 plastic grocery bags.

In Michigan, Dow worked with Winpak—which supplied plastic scrap—and Bit Mat Products of Michigan, K-Tech Specialty Coatings, and Central Asphalt to pave four roads in Midland County, as well as parking lots at the Global Dow Center and at Saginaw Valley State University. This was the second phase of Dow's RPMA road projects in North America, following the successful construction of two roads at the company's Freeport, Texas, facility.

For the Michigan projects, Dow used a type of recycled plastic that is commonly found in food packaging. The plastic films were collected and melted into a pellet shape, and the pelletized plastics were then sent to local asphalt plants where they were added into a binder and eventually into asphalt, mixing the materials into a formulation to match project specifications.

Before the U.S. projects, asphalt modified by Dow's ELVALOY™ technology debuted in Depok City, Indonesia, in 2017, after the Indonesian government announced that it intended to do its part to reduce plastic waste in the ocean by 70% by 2025. In total, Dow has now incorporated recycled plastic into roads and parking lots in Europe, Latin America, North America, and Asia Pacific.

In Michigan and around the world, Dow works with local stakeholders, including recyclers, asphalt producers, governments, and NGOs that share the company's vision of developing valuable end markets for used plastics. Local recyclers provide the used plastics, which Dow and local road developers use to modify asphalt to fit road specifications.

Dow is encouraged by the success of its RPMA work in Michigan and Texas, and it is excited about the potential for more projects using ELVALOY™ technology as a polymer modifier for asphalt throughout the U.S. and other global regions. The company vets paving opportunities on both private properties and public roads with equal enthusiasm.

Dow will continue to perform extensive road testing and monitoring to evaluate and optimize the technology so that it can be adopted further, in addition to continuing to explore and develop potential new endmarkets that make circularity possible for plastics.

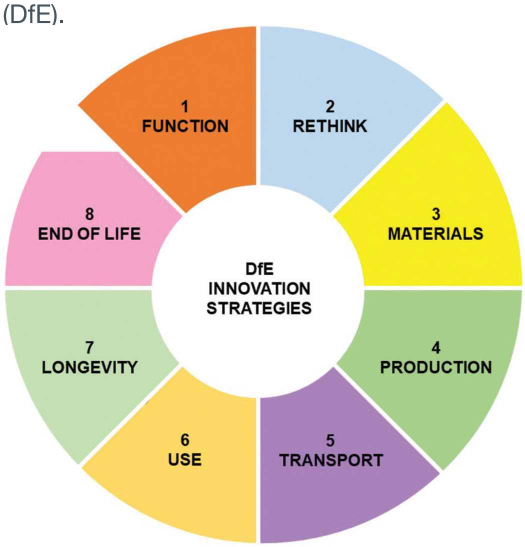
CASE STUDIES

KOHLER CO.: REDESIGNING ENGINES FOR CIRCULARITY

Since 1873, Kohler Co. has sought to provide a high level of gracious living to anyone touched by its products and services. From beautiful kitchen and bath products and innovative power solutions to developing clean water, sanitation, and community development solutions around the world, Kohler Co. believes that better business and a better world go hand in hand. It is Kohler's goal to enhance the quality of life for current and future generations through design, craftsmanship, and innovation fueled by the passion of more than 37,000 associates worldwide.

Kohler's Design for Environment Program

In 2011, Kohler Co. began using Life Cycle Inventory to understand the environmental impact of Kohler products and optimize the design of those products and the processes associated with manufacturing them. Circular economy principles directly correlate to what Kohler calls Design for Environment (DfE).



Design for Environment is exactly as it sounds. Kohler is designing new products and services with the environment in mind. The process starts by asking many questions, such as:

- What renewable materials can be used in this project?
- How can the company avoid creating a lot of waste?
- How can it be ensured that this product performs well but uses less water?
- How can the company design for serviceability?

The detailed step-by-step DfE model enables Kohler to make many improvements:

- Rethink design aspects, including materials, longevity, and disposal at the end of a product's useful life.
- Focus on how consumers use Kohler products.
- Look for opportunities to minimize a product's manufacturing, packaging, and transportation footprint.

As part of Kohler's Positive by Design program, the company is reshaping how it approaches the design of everything. Kohler Co. has had many success stories using the DfE Model, but none so prestigious and impactful as the Crackle Collection Tile, in partnership with ANN SACKS. The WasteLAB at Kohler, in Kohler, Wisconsin uses pottery cull, iron slag, and left-over glazes and enamel powder to create this unique line of ceramic tiles. The tile is an example of looking at materials differently and diverting waste from going into the landfill.

The Circular Economy at Kohler Co.

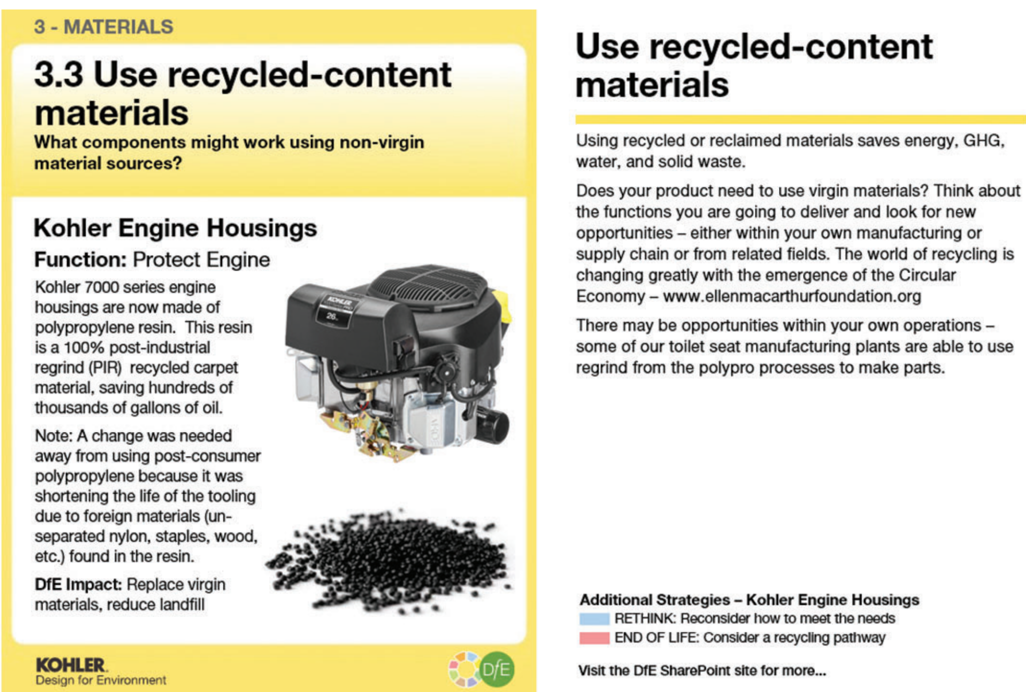
Being a diverse organization provides Kohler Co. with a tremendous opportunity to innovate, especially in terms of environmentally mindful design and materials. As part of a regular evaluation of existing and new product design in 2011, the Kohler Engines team identified an opportunity to update engine housings, which were originally made from plastic virgin material.

A cross-functional team of engineers and supplier quality specialists based in Kohler, WI, collaborated with the housing manufacturer and resin supplier in Evansville, Indiana, to evaluate recyclable materials to replace the virgin plastic. Throughout the process, the team manufactured and tested a large quantity of parts for functionality and analyze dimensional capabilities. A polypropylene, made from post-consumer recycled waste, was selected during the first phase of the project.

Using post-consumer waste posed challenges to the team as the waste often contained nondesirable foreign materials, such as un-separated nylon, staples, and wood. These foreign objects shortened the life of the tooling equipment, leading to inefficiencies in the manufacturing process. Upon further evaluations and testing, the team changed the material to 100% post-industrial regrind, made from recycled carpet waste. Using post-industrial waste is an example of industrial symbiosis, in which the consumption of energy and materials is optimized and the byproduct or waste of one industry serves as the raw material for another industry.

The team also reevaluated other engine parts, such as blower housing, air cleaner covers, and bases, which were subsequently switched over to the post-industrial material. Another learning curve for the team in using the recycled material was managing the tight dimensions with limited tolerance. The team mitigated this issue in 2013 by redesigning the 7000-series, this time with recycled materials in mind.

Minor adjustments were made to the recycled plastic parts, making it easier to assemble and accommodate how the material shrinks and distorts. Switching to the recycled material in 2011 took much effort, but no more than switching to a different manufacturer or grade of material.



CASE STUDIES

PROCTER & GAMBLE: HOW2RECYCLE

The Procter & Gamble Company (P&G) focuses on providing branded products of superior quality and value to improve the lives of the world's consumers, now and for generations to come. The company was incorporated in Ohio in 1905, having been built from a business founded in 1837 by William Procter and James Gamble. Today, P&G's products are sold in more than 180 countries and territories serving the needs of more than 5 billion consumers a day.

More and more, the world is depending on companies to make sustainable choices. As one of the largest consumer goods companies in the world, P&G feels an environmental responsibility to do the right thing.

During Earth Week in 2018, P&G released new sustainability goals called Ambition 2030. These broad-reaching goals have one purpose in mind: to enable and inspire positive impact on the environment and society while creating value for P&G as a company and for consumers. P&G has committed that 100% of its packaging will be recyclable or reusable.

As part of P&G's Ambition 2030 commitments, the company has committed that 100% of its packaging will be recyclable or reusable. P&G understands that for its packaging to be recyclable in a circular economy, it must be collected, sorted, and processed and end markets must exist for the resulting material. To enable the full value chain of recycling, P&G's Family Care brands first design for recyclability. P&G's Bounty and Charmin brands include the How2Recycle label on the packaging instructing consumers to recycle the polyethylene film wraps through store takeback and recycle the cardboard cores in their home recycling. Puffs cartons are also recyclable by consumers through curbside recycling. To help ensure end markets for recycled materials, Bounty and Charmin cardboard cores and Puffs cartons will contain 100% recycled fiber within five years.

P&G Family Care's journey to enable the circular economy model started by defining what needed to be true for packaging to be recyclable. First, Bounty and Charmin wraps had to be constructed of a mono-material. Polyethylene bags were collected by many major retailers, so this was a good place to start. Bounty and Charmin were able to design polyethylene wraps that could be recycled in this existing stream.

The How2Recycle is a standardized labeling system that clearly communicates recycling instructions to the public. It involves a coalition of forward-thinking brands that want its packaging to be recycled and is empowering consumers through smart packaging labels. By utilizing the How2Recycle label, Charmin and Bounty communicate to consumers that they can recycle the packaging by returning the wraps to the store on their next shopping trip. The bags and wraps collected via in-store take back programs are processed and converted into a new film or are used in composite building products.

In addition to enabling the store to take back film, P&G is also supporting a large-scale pilot to demonstrate the feasibility of curbside collection of flexible film packaging. Curbside collection of flexible film could unlock the recovery of millions of pounds of valuable material that currently goes to landfill—helping further the circular economy objectives. The initial pilot covering 300,000 households is an important first step in trying to scale and reapply the approach.

Charmin, Bounty, and Puffs also looked at what could be done to support the circular economy. By working to convert the cardboard cores and cartons to 100% recycled fiber content, the brands will be supporting paper recyclers by purchasing recycled materials. The cardboard cores and cartons are also recyclable, continuing the circularity of those packaging components.

By 2025, all of P&G Family Care packaging will meet the criteria of the circular economy model.

CASE STUDIES

SAPPI NORTH AMERICA, INC.: THERMAL ENERGY CIRCLES

Sappi North America, Inc. is a market leader in converting wood fiber into superior products that customers demand worldwide. The success of the company's four diversified businesses —high-quality Coated Printing Papers, Dissolving Wood Pulp, Packaging and Specialty Papers, and Casting and Release Papers—is driven by strong customer relationships, best-in-class people and advantaged assets, products, and services. As the world is demanding more and more from the planet and resources are being consumed at unprecedented rates, Sappi is dedicated to operating its manufacturing sites in a highly sustainable manner.

The pulp and paper industry is water and energy intensive, and Sappi North America's Somerset Mill saw an opportunity to reduce both its energy associated footprint and its costs. The Maine-based mill was built in the 1970s and 1980s and wanted to improve upon many of its older practices. A project was developed to provide process hot water for Paper Machine No. 2 (PM2) and Paper Machine No. 3 (PM3) using recovered heat to offset the use of low-pressure steam.

Originally, the Somerset Mill was designed to generate hot water for its paper machines using low pressure steam, which was produced by way of burning fuels, a costly method. Now, newly installed heat exchangers capture wasted heat and use it to heat the water needed elsewhere in the manufacturing process.

The update included adding heat exchangers, ductwork, pumps, and a great deal of piping, instruments, and controls. Modifications were also made to the PM3's dryer steam system to reduce blow-through steam that was being used to generate hot water in the dryer section vacuum condenser. All of this enabled greater use of hot water generated from recovered heat and a reduction in steam use.

This project was commissioned to remain competitive with newer pulp and paper mills by reducing the operating costs of PM2 and PM3, decreasing traditional fossil fuel use, allowing for reduced purchased electricity, reducing waste, and lessening greenhouse gas emissions.

Sappi leveraged a program administered by Efficiency Maine, which provides incentive grants to fund projects that reduce greenhouse gas emissions. This grant reduced the estimated project costs and increased its return significantly, making it a good business decision as well as falling in line with the company's sustainability goals.

Because the project reduces the mill's steam production requirements and fuel use in its power boilers, it is projected to save more than 3,700 tons annually of greenhouse gas emissions. By supplying PM2 and PM3 hot water tanks with water heated by recovered heat sources instead of steam, the steam valves that previously heated the water are now closed most of the time—thereby reducing low pressure steam requirements.

In the first three months of operation, the project saved Sappi North America more than 39,500 gigajoules of energy derived primarily from a reduction of fossil fuel use by the power boilers and the generation of additional electrical power in the mill's steam turbine generators to offset purchased power. The project was estimated to save 158,000 gigajoules of energy annually, and although this is less than 2% of the Somerset Mill's energy use, it equates to hundreds of thousands of dollars in annual savings. This is equivalent to the annual energy to heat 1,600 single family homes.

Sappi North America hopes that these experiences encourage other companies in the pulp and paper industry—and any energy intensive industry—to make similar, sustainable changes.

CASE STUDIES

SCHNITZER STEEL INDUSTRIES, INC.: RECYCLING TODAY FOR A SUSTAINABLE TOMORROW

At Schnitzer, sustainability is at the core of what the company does every day. With approximately 100 auto and metal recycling facilities throughout the U.S., Western Canada, and Puerto Rico, Schnitzer diverts and reuses millions of tons of materials each year that might otherwise be destined for landfills. The ferrous and non-ferrous scrap metal it processes is used to manufacture new metal-based products that reduce energy consumption, conserve natural resources, and significantly reduce greenhouse gas emissions. Based on ferrous scrap volumes in fiscal year 2019, Schnitzer avoided over 4 million metric tons of CO_2 emissions. This is the equivalent of taking more than 900,000 cars off the road for an entire year. Also, Schnitzer's efforts saved 10 million gigajoules of energy, enough to power 260,000 homes for a year, and over 7 million cubic meters of water, equivalent to almost 5,400 Olympic-size swimming pools. And, impressively, Schnitzer's industry-leading recycling technologies helped avoid the use of over 10 million cubic meters of landfill space, equivalent to the amount of landfill used by almost 6 million U.S. residents annually.

Schnitzer supports a sustainable future with its circular cradle-to-cradle business model. The model keeps end-of-life metal products from ending up in landfills, giving these products a new, useful life and preventing additional virgin, raw materials from being mined to make new metal-based products. Indeed, Schnitzer's business model is about creating sustainable value where others see obsolete products.

Auto Dismantling

Through Schnitzer's Pick-n-Pull brand, it operates an industry-leading chain of over 50 self-service used auto parts stores providing millions of recovered, affordably priced auto parts to retail and wholesale customers on an annual basis. Pick-n-Pull stores recycle everything possible. When a vehicle first enters a Pick-n-Pull location, the company begins by removing and recycling fluids, such as lubricating oils, hydraulic fluids, gasoline and diesel fuels, coolants and washer fluids, and refrigerants. Pick-n-Pull's recycling process also includes batteries and tires, which are resold or recycled depending on their condition. Next, the car is transferred to a sales yard, where customers can remove the parts needed as a sustainable and cost-effective alternative to purchasing from new part sources. Once most or all usable parts have been removed, the vehicle is crushed and sent to Schnitzer's metal shredders, where the next phase of recycling begins.

Examples of Materials Recovered in Fiscal Year 2019 from End-of Life Vehicles:

- **1,700,000 gallons of fuel**
- **9,700,000 pounds of batteries**
- **12,000,000 pounds of tires**
- **1,300,000 gallons of used oil**

Metals Recycling

An essential part of the metals recycling process occurs between the collection of scrap and its transformation into new products. Metals must be sorted, broken down into appropriate sizes for melting, and compacted for delivery to customers. Schnitzer's recycling yards and shredding facilities perform this fundamental role. They process these metals by shearing, torching, baling, and ultimately sending the material through shredders, which break down materials more efficiently than manual processing, yielding an end product that is denser and more suitable for use by steel mills. Beyond ferrous product, non-ferrous metals recovered include stainless steels, aluminum, copper, brass, and zinc, which are also recycled into new products.

Schnitzer uses enhanced non-ferrous separation capabilities to extract a greater volume of non-ferrous material to sell and further reduce metal material diverted to landfill. The separation technologies Schnitzer employs include magnets, eddy currents, air jets, and electronic and near-infrared sensors that sort and identify materials down to just a few millimeters in size.

Currently, Schnitzer is exploring a state-of-the-art gravity separation design that would sort materials even more finely, expanding landfill diversion capabilities even more.

Steel Manufacturing

The final stage of Schnitzer's internal recycling process is the manufacturing of new steel products, which takes place at Cascade Steel Rolling Mills in McMinnville, Oregon (Cascade Steel). The processes involved in steelmaking have been used for generations. However, today, 21st century advancements in technology make this process safer, more streamlined, and more energy efficient than ever before. Schnitzer's state-of-the-art electric arc furnace (EAF) and ladle refining furnace technologies use carbon-free electric power to melt scrap, operating with lower emissions than conventional basic oxygen furnaces.

Cascade Steel also finds sustainable uses for the byproducts of its steelmaking process, such as EAF dust and slag. When its steel products, including straight and coiled reinforcing bars, are shaped, cooled, and ready for sale, they are transported and used in sustainable ways to construct, among other things, new roads, bridges, houses, and commercial buildings—infrastructure that makes a positive impact on the communities where Schnitzer operates and beyond.

CASE STUDIES

STEELCASE: PARTNERING TO FOSTER THE CIRCULAR ECONOMY

Steelcase is the global leader in creating products and solutions for offices, schools, health care facilities, and other types of workplaces. Over 100 years old, Steelcase is the largest global furnishings and work environment company with about $3 billion USD in sales, more than 800 dealer partners, and 1,700 patents worldwide. In the last five years alone, it has served over 110,000 companies.

During past decades, Steelcase has successfully set and achieved its sustainability objectives. The inspiration and support for sustainability at the company initially came from an influential trustee, Peter Wege, the son of a founder of the company and an avid environmentalist. For him, the essence of sustainability was in people and doing good. “Do all the good you can, for as many people as you can, for as long as you can,” he often said.

This philosophy has been the bedrock of Steelcase’s sustainability efforts for many years. It drives the company to set and meet ambitious targets for reducing emissions, energy, water, and waste. It has also inspired Steelcase’s product design strategy and deep investments in materials chemistry. Knowing the innovation potential of sustainability and the benefits to customers and society, the company now has pilots and partnerships that build out the business case for a circular economy.

In 2018, China banned importing most recyclable commodities, which directly impacted the market globally as well as Steelcase’s local markets, and limited the company's ability to recycle certain commodities that had been easily recyclable like shrink wrap, plastic wrap, and foam wrap. To ensure that these materials avoided landfills, Steelcase developed a partnership with Trex—the leading recycled materials manufacturer of wood-alternative decking, railings, and other outdoor items—to obtain and reuse these recyclable materials from Steelcase.

The Steelcase-Trex partnership started small, with a pilot at its Kentwood, Michigan, location. Once the system was established and perfected, it was scaled to the company’s five other Michigan sites. The project entails collecting plastic wrap in bags, which are then baled, stored on site, and transferred to Trex every quarter, depending on Steelcase’s production schedule. Trex coordinates its pickups with a nearby company involved in a similar program to reduce the hauling for both sites and optimize plastic bale loads.

Steelcase was able to negotiate sending materials to Trex instead of the landfill to support Trex’s feedstock needs for plastic decking products. This took a wholesale change in Steelcase operations to collect, bale, and transport the material to Trex, which involved buy-in from multiple internal stakeholders like Steelcase’s logistics, materials, plant managers, and sustainability teams.

To make the project a success, there were a few challenges to consider and design around. For example, there were initial ergonomic concerns from the contractors baling the materials. After several discussions and considering various options, Steelcase and other stakeholders concluded that bagging the material would be most efficient so that the materials were easier to grab and bale. Steelcase also realized that in order to avoid cross-contamination of materials, it needed to dedicate a baler in each location to processing only one material and transport materials to be baled between locations.

The outcomes from the Steelcase-Trex partnership are impressive. It has positively impacted Steelcase's landfill diversion goals of 25% by 2020 by diverting 45 tons from landfill since the project started in June 2018. In addition, it has reduced Steelcase's need for virgin materials and production and provides feedstock to Trek for its wood-alternative decking. As a result of this progress, total annual savings are roughly $60,000 given the landfill diversions and hauling cost savings.

Several lessons have been learned from the partnership. Early buy-in from both internal and external stakeholders made the process smoother, which was facilitated by calculating and demonstrating the cost-savings opportunities and ROI to make the case for the project. Further, support from senior management and plant managers and detailed, frequent communications about the project helped garner the approval of employees.

Going forward, Steelcase will continue the recycling project in its Michigan sites and is exploring how to scale it to other locations in the U.S. and Mexico.

CASE STUDIES

WESTROCK COMPANY: ADVANCING FOODSERVICE PACKAGING RECYCLING

The paper industry has been planting trees and manufacturing products made from renewable and recyclable fiber in the GLR for more than 100 years. Sustainable forestry practices and continued demand for forest products have contributed to the growth of forests across the U.S., and the nation has more trees today than it did on the first Earth Day in 1970. Ensuring forests are healthy and productive is critically important. Forests provide habitats for diverse species, remove CO_2 from the atmosphere, and act as natural filters to protect fresh water supplies.

Papermaking is inherently circular. Paper mills use wood not only as a primary raw material, but the residual bark, pulping liquor, and wood fiber are used as a renewable energy source. Mills that use virgin wood fiber recycle pulping chemicals internally and reuse process water about 10 times on average before treating it and returning it to the environment. Paper mill byproducts also can be used as raw materials for nonpaper products, such as agricultural soil amendments and animal bedding.

Paper is one of the most recycled materials in the U.S., with recovery growing to an average of 68%, and packaging recovered from industrial, commercial, and residential consumers is recycled into new paper products. Paper mills in the GLR, including WestRock's 100% recycled paperboard mills, are leading industry efforts to increase recovery further by recycling packaging that has not been widely recycled in the past—specifically paper cups and other foodservice packaging.

Historically, paper-based foodservice packaging, which includes items such as single-use cups, takeout cartons, and pizza boxes, has not been widely accepted in recycling programs owing to concerns over polymer coatings and food contamination. Paper cups, in particular, have not been widely accepted in recycling programs owing to concerns over the thin polyethylene lining that acts as a barrier to liquids. Many believed this lining could not be removed in a typical continuous pulping process, where operating conditions employ short dwell times and low temperatures, or at mills without an enhanced screening system to remove the liner.

Recent testing by WestRock has found that, in fact, the poly-lining does separate cleanly during typical pulping conditions and is removed by typical screening systems. Since there are low volumes of poly-lined paperboard on the market and available for recycling, this product can be mixed into existing streams, such as a residential mixed paper, and processed at paper mills without impacts to yield, the production process, or finished product quality. Mills that batch pulp aseptic and gable top cartons also are able to incorporate poly-lined foodservice packaging into its furnish.

The number of cities accepting cups and other foodservice packaging in residential recycling programs is growing. WestRock recycling facilities in Chattanooga, Tennessee, and Louisville, Kentucky, began accepting foodservice packaging in its residential recycling collection in 2017. This packaging is then processed at the company's paper mills into various new fiber-based packaging products, including cereal and tissue boxes.

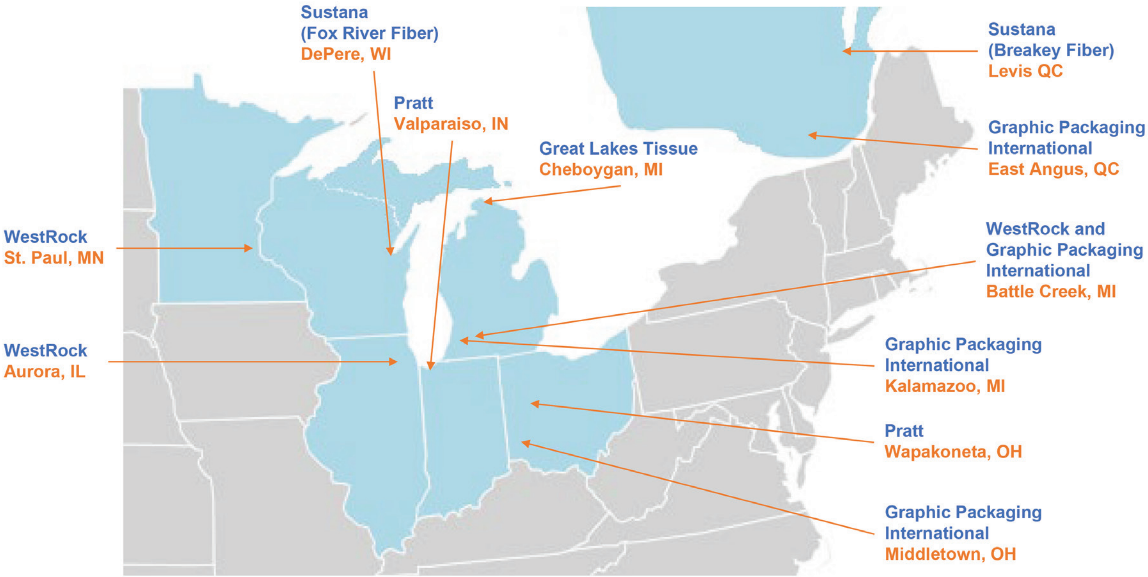
Today, in the GLR, many paper mills accept paper cups, milk cartons, and juice cartons in the recycled furnish they use.

In the case of Sustana, recycled cups are used to make post-consumer bleached recycled pulp that can be incorporated into new paper cups. Sustana, WestRock, and Seda, a cup manufacturer also located in the GLR, have partnered with Starbucks to demonstrate how used cups can be recycled into new ones.

The paper industry in the GLR is doubling down on its commitment to recycling by accepting additional packaging types for processing. The industry is looking to partner with communities in the GLR to bring this the circular economy opportunity to scale.

WestRock is a multinational provider of paper and packaging solutions for consumer and corrugated packaging markets. It partners with its customers to provide differentiated paper and packaging solutions that help them win in the marketplace.

Location of paper mills that accept foodservice packaging in the GLR



POSITIVE SOCIAL IMPACTS OF THE CIRCULAR ECONOMY IN THE GREAT LAKES REGION

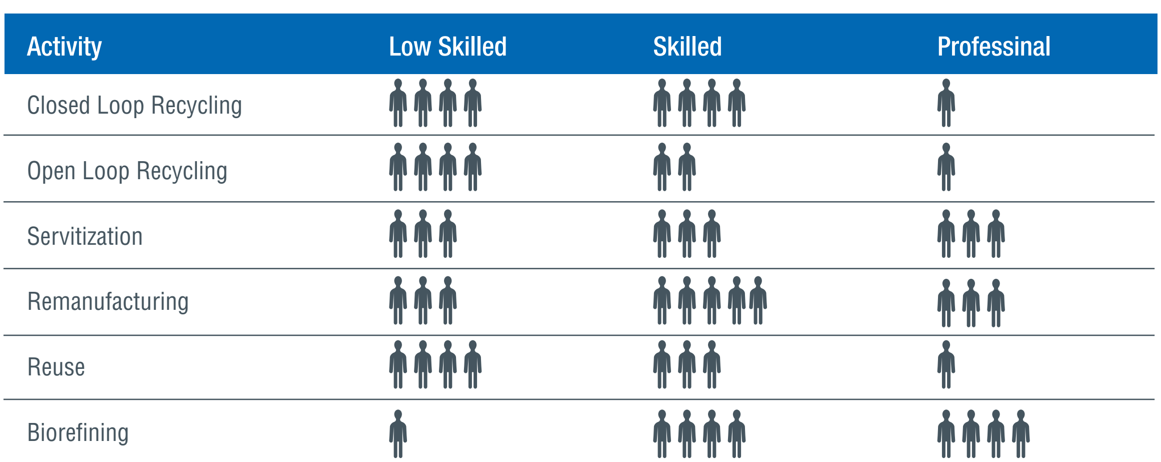
In addition to the environmental and economic benefits, the circular economy brings a number of positive social impacts through job creation, GDP growth, and alignment with the United Nations Sustainable Development Goals (SDGs). For example, shifting the material flow toward circularity often requires new mechanisms and working group involvement. With some local policy and practical interventions, circular economy projects could support a wide group of community stakeholders (including vulnerable populations) by providing job training, offering business opportunities, helping to transition labor skills to avoid labor disruption, and enhancing the affordability of goods and services through shared/leasing business models, among others.

Although not estimated specifically for the GLR as part of this study, social benefits in the region would roll out in the value chains of the materials considered in this analysis and to the regional economy. Social benefits are equally important to capture as environmental and economic benefits for the circular economy. They maximize not only the positive impacts but also the uptake of the circular economy, ensuring that the development toward circularity is sustainable to the environment, the economy, and society.

Contribution from the Circular Economy toward Jobs and GDP Growth

A number of key activities related to the circular economy have the potential to expand, creating new job opportunities in the future. The Waste and Resources Action Program has examined the types and relative numbers of jobs that may be required by the circular economy in Britain (see Figure 8).[60] The potential for job creation in circular business models does not just occur in remanufacturing and recycling. It also occurs in new business through servitization, or the business-model shift whereby firms develop capabilities to provide services and solutions that supplement traditional product

Figure 8. Potential skill requirements for circular economy activities



Source: Waste and Resources Action Program, *Employment and Circular Economy Job Creation in a More Resource Efficient Britain*, London, England, 2015.
http://www.wrap.org.uk/sites/files/wrap/Employment%20and%20the%20circular%20economy%20summary.pdf

offerings.[61] It can include leasing and moving from providing products to services instead, thereby deferring consumption of new assets.[62]

For example, the construction sector provides 18 million direct jobs and contributes to about 9% of the EU's GDP.[63] While the economic and social impacts of the circular economy are not often estimated at a construction product level, potential growth in recycling, recycled content repair and remanufacturing, and bio-based solutions could help the construction product sector reduce its dependency on fossil fuels and become more resilient to future regulatory and policy changes on climate change, as well as create jobs in the sector. In London, the circular economy is expected to bring 12,000 new jobs to the construction sector in London by 2030.

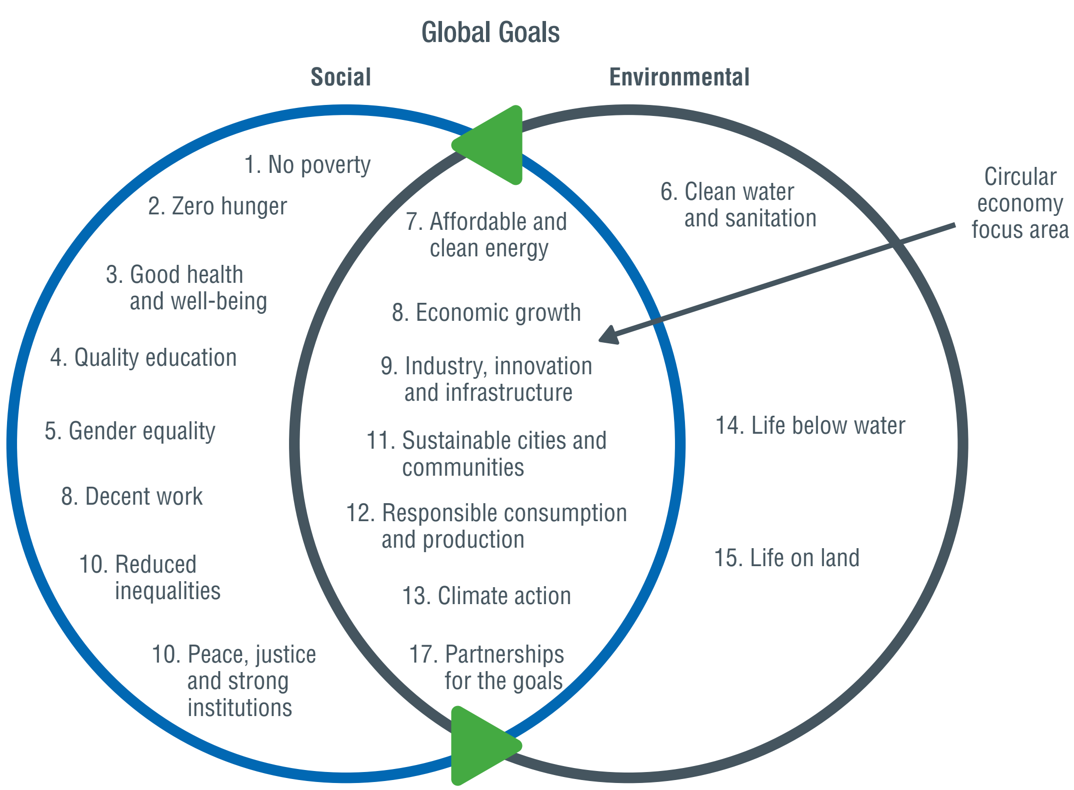
With the construction sector employing almost 1 in 20 working people, there is an opportunity to increase jobs in construction related reuse, remanufacturing, repair, and maintenance.[64]

Contributions from the Circular Economy Toward the Sustainable Development Goals (SDGs)

Although nations, cities, and organizations are working to reach the 17 SDGs, achieving them are a challenge. The circular economy can offer the strategies and tooling necessary to develop new ways toward a sustainable economic system while directly and indirectly working on the 17 SDGs.

The circular economy directly influences climate action (Goal 13) by reducing GHG emissions through resource efficiency. It also focuses on affordable and clean

Figure 9. Contributions from the circular economy to United Nations Sustainable Development Goals



energy (Goal 7) by upscaling green energy possibilities. On the production side, circular strategies require innovation and different infrastructure (Goal 9). On the consumer side, a circular way of thinking will stimulate consumers to responsible consumption (Goal 12). The new ways of working will stimulate sustainable cities and communities (Goal 11), as well as sustainable economic growth (Goal 8). Development of the circular economy also requires partnerships (Goal 17) between nations, cities, and organizations. While working on these goals, the circular economy will indirectly influence the other SDGs as they are interconnected. Figure 9 lists the SDGs and highlights where the circular economy can have an impact.

CHALLENGES OF THE CIRCULAR ECONOMY IN THE GREAT LAKES REGION

While the potential savings for companies in the GLR to adopt a circular economy are great, obstacles may need to be surmounted to fully realize them.

Internally, there are several issues that can hinder companies from embracing a circular model. Product design for a closed loop system necessitates a reenvisioning of work and process flows for much of the private sector, which can be resource intensive, complex, and in competition with other design priorities. In addition, a diverse and specialized supply chain may be required to accommodate the developing technologies and materials associated with a circular economy, making initial production coordination in supply chains challenging. Moreover, a lack of end markets for the circular economy-based products can create little economic value for companies to switch to a circular model, though development in this area is slowly evolving.[65]

External factors also contribute to complicating a shift to circularity. Insufficient waste management systems that contribute to the contamination of recycled materials may inhibit the acquisition of appropriate circular product materials that can impede progress toward circularity. For example, consumer or industry noncompliance with recycling standards or the inability of materials recovery facilities (MRFs) to adequately detect and eliminate contaminated materials from the recycling stream jeopardizes the creation of clean, usable circular product materials. Incentivizing companies to utilize virgin materials or low disposal fees at landfills may further encourage reducing, reusing, and recycling.[66]

From a cost perspective, commodity prices have become increasingly volatile. Although finite resources like steel, which has increased nearly 300% in price since 2000, are obvious candidates for a circular system, the use case for plastics is more nuanced. The price of crude oil and technological barriers in the recycling of plastics can diminish its overall energy efficiency in a closed loop system. And the cost of wood pulp has fluctuated drastically over the past 35 years, making it difficult to create resiliency against price changes for paper.[67]

Solutions to overcome these challenges are multifaceted. Collaborations like public-private partnerships can facilitate and mitigate risks involved with implementing circular models for companies. Finally, increasing consumer demand for sustainable products or investor demand for company sustainability overall may provide a greater impetus for companies in the GLR to adopt circular models.

KEY ACTIONS FOR SCALING THE CIRCULAR ECONOMY IN THE GREAT LAKES REGION

Based on this analysis, the following key takeaways and recommendations for the GLR can be made:[68]

Develop incentive mechanisms: Focusing on improving recycling processes, technologies, and yields (e.g., managing copper levels in steel, chemical recycling of plastic, reducing loss of steel scrap, and increasing mechanical recycling of plastic) that encourage innovation and greening of the value chain (e.g., plastic production that uses renewable energy) can move businesses toward circularity. For example, certain parts of the world, such as China, offer companies incentives to create materials with recycled content, including paper, tires, cement, and food and agricultural waste. While broad-based national-level policies may be difficult to execute in the U.S., states and localities within the GLR can consider ways to incentivize companies, and households where appropriate, to recycle more efficiently. The localities would benefit from decreasing the cost of waste disposal and strengthening the market for secondary materials where the future of production lies.[69]

Encourage partnerships and collaboration: Support for business models that better foster circularity and cross-sector collaboration, such as greater product sharing and value creation for waste streams, can lead to increased adoption of circular practices. The Green Deal of the Netherlands, for example, is an online platform that fosters innovation by piloting new partnership projects. In 2018, it established the Sustainable Healthcare for a Healthy Future Green Deal as a public-private partnership with various players in the healthcare value chain. The goals of this multi-sector collaboration are to reduce the sector's CO_2 emissions and pharmaceutical residues in water, improve health, and promote circularity through ideas like creating circular criteria for healthcare procurement.[70]

In the U.S., some of this work already exists on a national or commodity-based level. Groups like Closed Loop Partners, Ellen MacArthur Foundation, and The Recycling Partnership are developing coalitions across issues areas, like plastic, to bring companies and governments together to help build a circular economy platform.[71] For larger companies and governments, engaging in these types of programs are helpful to align efforts on a national scale.

In the GLR, there are already multisector partnerships working to build regionally based circular models. The West Michigan Sustainable Business Forum works in partnership with the business community on issues such as improving in-house waste diversion, supporting infrastructural changes to make the circular economy more efficient through more nuanced hauling and material transport, and working on focus materials like food waste.[72] Similarly, the Minnesota Sustainable Growth Coalition helps its members develop a stronger circular economy—especially around clean energy, water, and commodities.[73] Partnering with chambers of commerce and other local business and development organizations can create the informal engagements and formal partnerships required to develop circularity in a region.

The GLR's universities are also forming corporate partnerships to advance the circular economy, package sustainability, and other affiliated programs. Several GLR universities leading the way in scientific advancements in this space include the Rocheste Institute of Technology, Michigan

State University, The Ohio State University, and Purdue University. Cross-sector partnerships with academic institutions will be critical to expand the circular economy in the GLR and around the world.

Align the circular economy with mainstream practices: The European Commission's EC CE Package links various circular initiatives that encourage material efficiency, ease of repair, and more streamlined end-of-life treatment. Circular concepts that have promoted new projects, pilot testing, and support of industry and small- and medium-size businesses are also found in other programs such as the Europe 2020 Strategy, the Product Environmental Footprint (PEF), Horizon 2020 program, the LIFE program, and the Cohesion Policy. While policies are not generally efficient across regions or companies of different industries and sizes, outcomes from some of these efforts highlight some of the ways that the private sector could integrate and benefit from the circular economy.[74]

Develop traceable actions and targets: The circular economy can develop by driving tangible results and making it easier for stakeholders to track and share their progress. Setting specific targets in a quantifiable and transparent way, the EC CE Package aspires to achieve goals in production, consumption, secondary raw materials and innovation by focusing waste as a resource and improving resource productivity. For example, resource productivity targets include a 30% increase by 2030, resulting in 0.8% increase in GDP and adding 2 million jobs. With specific targets for multiple materials, including plastic, packaging waste prepared for reuse and recycling could increase to 80%. The package also includes an open monitoring framework that consists of an online database tracking over 20 specific metrics on circular activities.[75]

Embrace the social aspects of the circular economy: Businesses can implement measures to support the social shift toward the circular economy (e.g., expert training in repair services and incentives for social co-benefits) or by taking a broader perspective when developing circular policies or actions to align with the SDGs. For example, Japan's Sound Material Cycle Society policy promotes social change, minimizing the consumption of natural resources, and reductions in environmental load in alignment with the 3R concepts (reduce, reuse, and recycle). It integrates amelioration of the environment, economy, and society toward a more sustainable society specifically designed with the SDGs in mind.[76] Stateside, organizations like Plant Chicago are fostering the social aspects of circularity in businesses and local communities in the GLR through education, networking, and other initiatives.

GOING FORWARD

This report demonstrates the economic and environmental opportunities for companies involved in steel, plastics, or pulp and paper that seek to implement the circular economy in the Great Lakes Region. Given this potential, similar opportunities may exist with other materials and in other regions of the U.S. Equally, such data might be extrapolated nationally to determine broader effects of the circular economy in the U.S. These topics could be explored in future research.

Novel, disruptive programs and technologies are being created in the Great Lakes and St. Lawrence Regions to move the economy from a linear to a circular one. With continued circular advancement, further economic and environmental gains will be achieved that put the region on a path to better business and a more sustainable future.

APPENDIX A: LIST OF INPUTS FOR CALCULATIONS

Several inputs and assumptions were used to calculate the circular economy measures for the three materials.

Steel

- European and GLR production were necessary for baseline calculations.[77, 78, 79, 80]
- The GLR will see the same steel production growth rate (-21%) as the European Union (EU) through 2050.[81]
- The share of secondary steel in the EU in the baseline and the share of secondary steel in the GLR in the baseline were calculated.[82, 83, 84]
- Steel losses currently sit at 9%, but by 2050, these losses can be eliminated, and the cost of replacing losses (primary steel production cost) is $542 USD per tonne.[85]
- A circular business model focuses on increased sharing, especially with respect to automobile sharing, and longer life spans of products.[86]
- Savings can be achieved through better collection of end-of-use products, the forming of new scrap, and reducing remelting losses.[87]
- The GLR will see the same emissions intensities for primary and secondary steel production as the global average by 2050 (1.9 and 0.1 tCO_2/t steel, respectively).[88, 89]
- Without managing copper contamination, a greater share of primary steel (32%) is needed by 2050. Managing copper contamination reduces the need for primary steel production by 2050 to 13%.[90]

Plastic

- European and GLR production were necessary for baseline calculations.[91, 92]
- European and GLR recycling rates were necessary for baseline calculations.[93, 94, 95]
- The share of secondary plastic used in production was necessary for baseline calculations.[96]
- Increased mechanical recycling can occur through a combination of a higher collection rate and yield.
- The share of secondary plastic used in production (9%) is the same as the global average in the baseline.
- Chemical recycling is possible on an additional 25% of nonrecycled (mechanically) plastic and results in some CO_2 emissions. But, it eliminates embedded and productions emissions from new fossil feedstock.[97]
- Additional abatement potential in 2050 is possible through more recycling, substitution with other materials, renewable energy in production, bio-based or CO_2 feedstock, and process innovation. By 2050, additional abatement potential occurs after 100% energy recovery from plastic waste has occurred.
- The emissions saving intensity per tonne of plastic (1.45 tCO_2/t) in the EU is applied to the GLR based on its estimated plastic demand.[98]

Pulp and Paper

- Annual Finnish and GLR paper production were necessary for baseline calculations.[99, 100]
- The ratio of monetary savings per unit of functional product in Finland is applied to the GLR based on its pulp and paper production.
- Raw wood contains 30% lignin, and the share of lignin for all functional products is 25%. [101, 102, 103, 104, 105, 106]
- The wood input ratio for pulp and paper (t wood/t paper) is 2.67.[107]
- Emissions savings for functional products are based on life-cycle analysis for bio-based adhesive (mid-value products) and bio-based adipic acid (high-value products).[108, 109]
- Changes in regulations and technology make ash and other waste an input with value to production, and all currently landfilled waste will be used. Wastes include sludges, ash from production, and other industry waste.[110]

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ABOUT NAVIGANT – A GUIDEHOUSE COMPANY

Guidehouse is a leading global provider of consulting services to the public and commercial markets with broad capabilities in management, technology, and risk consulting. We help clients address their toughest challenges with a focus on markets and clients facing transformational changes, technology-driven innovation and significant regulatory pressure. Across a range of advisory, consulting, outsourcing, and technology / analytics services, we help clients create scalable, innovative solutions that prepare them for future growth and success. Headquartered in Washington DC, the company has more than 7,000 professionals in more than 50 locations. Guidehouse is led by seasoned professionals with proven and diverse expertise in traditional and emerging technologies, markets and agenda-setting issues driving national and global economies.

With over 600 consultants, Navigant's global Energy practice is the largest energy management consulting team in the industry. We collaborate with utilities, government and NGOs, industries and large corporations, product manufacturers, and investors to help them thrive in a rapidly changing energy environment. Our clients include the world's 60 largest electric, water, and gas utilities; the 20 largest independent power generators; and the 20 largest gas distribution and pipeline companies. Navigant's seasoned professionals and highly skilled specialists form exceptional teams to help clients transform their businesses, manage complexity and accelerate operational performance, meet compliance requirements, and transform systems and governance to address upcoming changes as the energy transformation takes hold.

U.S. CHAMBER OF COMMERCE FOUNDATION CORPORATE CITIZENSHIP CENTER

The U.S. Chamber of Commerce Foundation Corporate Citizenship Center helps advance the positive social, economic and environmental impact of business. The Center works to educate the public and the business community on the positive efforts of business through best-in-class communications, fact-based research, and a convening power that brings together key business and policy leaders.

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