



SCALING SUSTAINABLE PLASTICS

Solutions to drive plastics
towards a circular economy



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Ocean
Recovery
Alliance



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ABOUT TRUCOST

Trucost helps companies and investors to achieve success by understanding environmental issues in business terms. Our data-driven insights enable organizations to manage risks and identify opportunities for growth. We are the world's leading experts in quantifying and valuing the environmental impacts of operations, supply chains, products and financial assets. By putting a monetary value on pollution and resource use, we integrate natural capital into business and investment decisions.

With offices in Europe, the US and Asia, Trucost works with businesses worldwide to increase revenues, improve communications, meet marketplace expectations and comply with regulatory requirements.

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EXECUTIVE SUMMARY

The use of plastic has advanced society by improving healthcare through its use in medical equipment, providing packaging to reduce food waste, and cutting transportation costs and emissions due to its lighter weight.

However, huge volumes of plastic are also used for disposable packaging and products leading to many negative environmental consequences. If predicted strong growth of plastics continues with production from fossil fuels, the plastics sector will be responsible for 15% of the 2050 global annual carbon budget needed to achieve the internationally accepted goal to limit global warming to 2°C⁵.

The sector is evolving. Innovation in the form of biodegradable plastics, recycled materials and plant-based polymers offer lower environmental impact in production. Closed loop recycling, transitioning towards the circular economy, offers further reduction of impact at end-of-use, and further reduces the impact of next generation manufacture of products. These opportunities are positive, but they are often happening in a fragmented way. In order for the sector to truly become circular, sustainability needs to be scaled up – and quickly.

This paper identifies two good practice case studies: Algix, a company producing a polymer called Solaplast from waste algae; and Dell, whose OptiPlex 3030 computer is produced using recycled plastic recovered from electronic equipment from its own take-back scheme. These innovations reflect both ‘front end’ and ‘back end’ value chain optimization, but in order for the benefits to be optimized, the whole sector needs to transition towards similar systems.

Scaling up use of sustainable plastic has its challenges. Industry experts identify technical issues in biopolymer production, as well as a hesitancy in the market, while recyclers are faced with competition from cheap virgin plastics due to low oil prices, as well as the export of waste plastic to Asia where recycling benefits from economies of scale and low costs, though anecdotally this is considered to be declining.

But amidst these challenges are many examples of success. Policies in some countries such as Japan have resulted in a recovery rate for plastic of more than 80%. Research in the UK identified 10-20% cost savings with the use of some recycled plastics, as well as supply chain security benefits and protection against future fluctuations of oil – a dwindling resource that is likely to become increasingly expensive.

The benefits of switching to sustainable plastic can be huge. If the entire computer manufacturing industry switched to using closed-loop recycled plastic, society would see an environmental benefit of \$700 million per year. Through the use of algae-based bioplastic, the footwear sector could reduce environmental costs of plastic by over \$7,000 per \$1m of revenue, equivalent to 5% of its total supply chain environmental cost. With a global revenue of \$208.7 billion¹⁷, this could reduce the environmental costs of the sector by \$1.5 billion per year. The soft drinks sector could benefit by an additional \$1.3 billion saving⁷.

This paper considers interventions required to transition the sector towards a circular economy. Collaboration is key. Stakeholders throughout the value chain, including manufacturers, plastic recyclers, brands, policy makers and academics need to communicate to identify the best options for innovation and implementation. Legislation on waste management and producer responsibility, particularly in the countries where consumption is highest, will help secure feedstock for next generation products. This may be difficult to implement but has been achieved in some countries. In addition, driving market demand for recycled plastic and biopolymers will help small projects expand to the size of conventional virgin plastic production, bringing costs down substantially.

INTRODUCTION

Plastic is everywhere. Packaging, electronics, furniture, vehicles – even clothing. It is one of the most versatile and useful materials in modern society and has many varied properties such as strength, durability, low weight and malleability which make it essential for this wide range of applications.

The plastics market has grown by 8.7% year on year from 1.7 million metric tons in 2005 to 288 million metric tons in 2012. China is the world's biggest producer, accounting for almost a quarter of all plastic¹².

Plastic has many benefits. Plastic packaging makes food last longer, reducing wastage. Use of plastic facilitates clean drinking water supplies and enables medical devices ranging from surgical equipment and drips through to aseptic medical packaging and blister packs for pills. Due to its light weight, plastic use in vehicles has reduced the carbon dioxide emissions emitted from vehicles¹.

But the use of plastic has come at significant cost to the environment. Research for the Ocean Recovery Alliance and UNEP in 2014 identified \$75 billion of annual natural capital costs from plastic use by the consumer goods sector alone¹⁸.

One of the most environmentally damaging impacts of plastic is greenhouse gas emissions associated with the use of fossil fuels as a raw material and energy source. Around 4-6% of oil production is used as feedstock to make plastics, and a similar amount is used as energy in the manufacturing process^{5, 16}. In addition, a myriad of chemicals is used in plastics manufacturing – plasticizers, stabilizers and flame retardants, to give just a few examples. Some of these compounds have been found to alter hormones or have other potential human health effects, as well as affecting reproduction and development in animals¹¹.

After it is used, plastic waste can create additional environmental damage. The most significant impact of plastic use by the consumer goods sector is marine pollution, which has a natural capital cost of at least \$8bn¹⁸. This is likely to be an underestimate due to the need for further scientific research, for example, on the impact of small particles of plastic known as microplastic. The extent of impact of microplastics is not yet fully understood, but it is known to cause significant harm to marine life^{2, 10}.

Some companies have been demonstrating leadership to reduce these impacts using innovative means. Plastic recycling, production efficiency and more responsible raw material sourcing have all improved in recent years, but more is needed to adopt these improvements at full scale across the entire sector, and create a plastics sector which can be considered truly sustainable.

Trucost and the Ocean Recovery Alliance have partnered to help the plastics sector transition more quickly towards a circular economy. The objective is to create a system in which plastic production is associated with low natural capital cost, in which inputs are renewable, non-harmful and are recaptured at the end of their first useful life to be recycled or repurposed into something of equal or greater value. By making this transition to industry-wide sustainable plastic use, society can continue to enjoy the many benefits of plastic without damaging the world in which we live. The report brings together industry expert opinion from a series of interviews and provides recommendations on the most important steps for all stakeholders to ensure a sustainable future for plastic use globally.

MAKING SUSTAINABLE PLASTICS THE NORM

What is a sustainable plastic? This paper considers the environmental impacts of plastics production and consumption, and does not discuss the wider social and economic aspects of sustainability. It focuses on opportunities to reduce the natural capital cost of plastic based on two key intervention points – reducing manufacturing impacts through alternative raw materials and minimizing chemical use, and reducing end-of-use impacts through the recovery and recycling of products.

ALTERNATIVE RAW MATERIALS

The conventional raw material of plastics is oil, the extraction of which is increasingly challenging due to dwindling resources. Currently, oil consumption for plastic use is approximately 6% of all oil consumed, equivalent to that of the global aviation industry. If growth continues as expected, the plastics sector will account for 20% of total oil consumption by 2050⁵.

The environmental impacts of oil extraction are well known, ranging from localized biodiversity impacts, water pollution, deforestation, soil erosion and other wide ranging detrimental effects^{3,14}. To overcome these impacts, bioplastics, or plastics produced with renewable materials have been developed. This includes plastics produced from a variety of natural feedstocks including corn, potatoes, rice, tapioca, palm fiber, wood cellulose, wheat fiber and bagasse.

Commonly misrepresented as biodegradable plastics, bioplastics may or may not decompose at end-of-use, depending on the type of plastic produced. Biodegradable plastics are often produced for a particular purpose, as they decompose at end-of-use, which can provide benefit if discarded. However, these plastics do have some trade-offs and can require more energy and even oil to produce⁴, so it is important they are only selected in scenarios where end-of-use management is appropriate and where product functionality is not reduced. Bioplastics can function at a similar or equal level to conventional plastics, though there are many varieties, so it is important to select the appropriate plastic for purpose. Using plant matter or waste materials as inputs can significantly reduce the environmental impacts of plastic production, as shown in the case study below.

CASE STUDY 1: ALGIX – MAKING THE CASE FOR MORE SUSTAINABLE PLASTIC

Algix is a green technology company that produces plastic composites called Solaplast made using algae blended with polyethylene, ethylene vinyl acetate polylactic acid and polystyrene. Solaplast was developed by Algix in response to increasing demand from companies in consumer-facing sectors for more sustainable types of plastic. Solaplast has a lower carbon footprint, alongside other environmental benefits, as a result of its reduced use of fossil fuels. Carbon is also absorbed by the algae as it grows, which is then locked away in the plastic.

Solaplast also provides a beneficial use for algae which is extracted from water treatment facilities or waste product from aquaculture. In rivers and lakes, algae has a damaging impact on water quality.

Algix wanted to show that switching to Solaplast could help companies decouple business growth from negative environmental impacts. The company was conscious of the need to avoid 'greenwash' – unsubstantiated claims about a product's environmental benefits – so it commissioned research to quantify the environmental performance of Solaplast compared to several conventional plastic resins (EVA, polystyrene, polyethylene and polylactic acid -PLA).

The study measured the full lifecycle environmental impacts of both types of plastic in physical terms, such as metric tons of greenhouse gas emissions and cubic meters of water used. Then it calculated the monetary value of the societal cost of those impacts in US dollars so they could be compared.

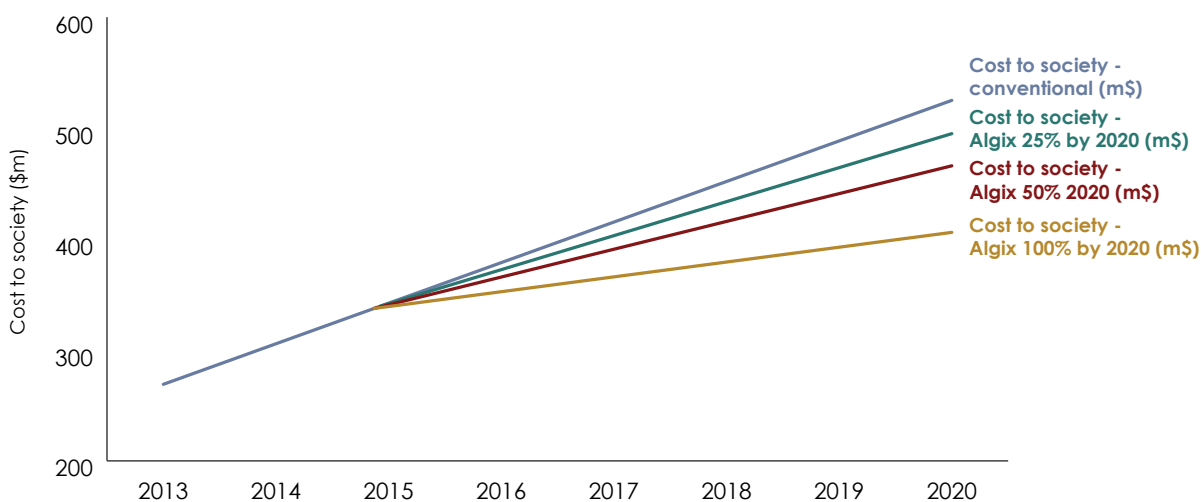
The results show that all Solaplast products have better environmental performance than their fossil fuel counterparts. The largest difference is for Solaplast compared to polystyrene, which has a higher environmental benefit of 49 ¢/kg of plastic. The increased benefits of Solaplast compared to PLA is 37¢/kg and for polyethylene 33¢/kg.

Over half of the environmental benefit of Solaplast comes from its reduced climate change impact as a result of its lower fossil fuel content, followed by resource use, human health impacts, ecotoxicity and water use.

The key markets that Algix is targeting with Solaplast are foam products for use in footwear, luggage, toys, sports goods and packaging. Solaplast could also be used in the emerging area of 3D printing of plastic products.

If Solaplast was adopted at a wider scale across the plastics industry, there would be a significant environmental benefit for society as well as a significant business opportunity for Algix. For example, the global polylactic acid market is forecast to grow from 361,000 metric tons in 2013 to 1,205,000 metric tons in 2020. The figure below shows the benefit to society under different scenarios if this increase is met by using Solaplast instead of conventional plastic.

FIGURE 1: WHAT ARE THE ENVIRONMENTAL BENEFITS TO SOCIETY OF WIDESPREAD USE OF SOLAPLAST TO REPLACE PLA?



Switching to Solaplast could help companies in consumer goods sectors reduce the risks they face as a result of the environmental damage caused by conventional plastic. The risks include government bans or restrictions on plastic products such as disposable plastic bags, the introduction of carbon taxes which could increase costs, and consumers turning away from plastic products in favor of alternatives that they perceive as being greener. Research in 2014 for the UN Environment Programme put the environmental cost of plastic in the consumer goods sector at \$75 billion.

For example, in the footwear sector, Solaplast could reduce environmental costs of plastic by over \$7,000 per \$1m of revenue, equivalent to 5% of its total supply chain environmental cost. A similar saving is apparent in the soft drinks sector, while for carpet manufacturers, the saving is nearly \$10,000 per \$1m of revenue, or 8% of total supply chain environmental costs (see figure).

FIGURE 2: ENVIRONMENTAL BENEFIT IN END-MARKET SUPPLY CHAINS



Algix has had to overcome numerous challenges to get to the point where Solaplast is ready to scale up. The company is developing a new production site in China which will double its current capacity. Algix has also developed its own algae processing facility to ensure access to enough good quality feedstock.

Ryan Hunt, Algix’s chief technology officer, says: “Consumers are concerned with environmental issues. Consumer-facing companies are moving towards more sustainable products, but are also wary of greenwash. Undertaking scientific assessment of the environmental benefits is an important communication tool to help assure customers that Solaplast is sustainable.”

RECOVERY OF MATERIAL AT END-OF-USE

Regardless of whether it is fossil fuel based or bioplastic, discarded plastic creates considerable environmental damage. The annual volume of globally traded waste plastics is around 15 Mt, less than 5% by weight of new plastics production in 2012 (ISWA, 2014). Discarded plastics often get thrown into landfill, where they take centuries to break down, or in the environment such as the ocean, where 4-12 million metric tons of plastic ends up each year (Jambeck et al, 2015). To put this in context, that is enough plastic to cover every foot of coastline on the planet.

Plastic litter in the ocean can injure and kill wildlife.⁹ Plastic bags, plastic strapping and abandoned fishing gear can strangle marine animals, while smaller items such as bottle caps, plastic cutlery and pens can be swallowed and harm animals through internal damage and starvation¹⁸. Plastic litter can also end up in other areas of the environment, polluting waterways and forests, causing injury to terrestrial wildlife through ingestion and entanglement and also create financial impacts through clogging sewers and urban infrastructure⁵. Through collection at end-of-use, this damaging waste can become a valuable feedstock.

In addition to preventing waste impacts, recycling plastic can displace virgin polymer requirements in a wide range of consumer products. Yet currently, after a short first-use cycle, 95% of plastic packaging material value, or US\$80–120 billion annually, is lost to the economy⁵. Examples of recycled plastic applications include, sanitary ware, electronic equipment, paint tubs, drinks bottles and other packaging products²⁰. Use of recycled plastic can be both advantageous environmentally, but also financially, with some recycled polymers offering 10 to 20% lower cost than the virgin equivalent²⁰. Dell is an example of the success possible through direct intervention – a consumer goods brand providing take back of its own electronics equipment and closing the loop on production.

CASE STUDY 2: DELL – COLLABORATING TO SCALE UP CLOSED-LOOP PLASTIC RECYCLING

Global technology leader Dell is reducing plastic waste by integrating recycled plastic into the design of its OptiPlex 3030 All-in-One desktop computer. What is unique from other recycling initiatives is that the recycled plastic comes from used electronic equipment recovered through Dell’s global take-back scheme – ULe certified ‘closed-loop’ recycling.

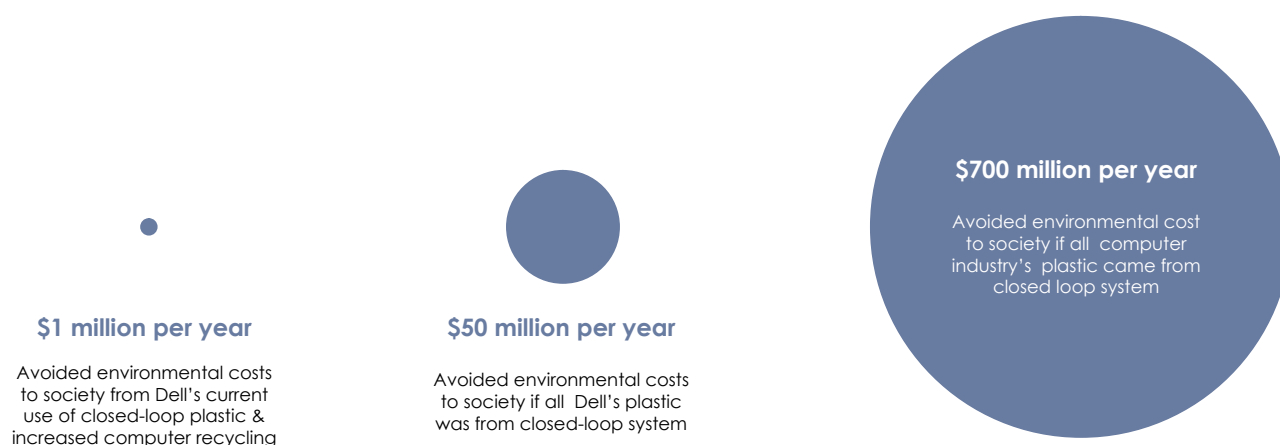
Dell is committed to improving the recycled content of its products as reflected in its sustainability targets. By 2020, Dell aims to increase the use of sustainable materials in its products to 50 million pounds (23 million kilograms) and to recover 2 billion pounds (900 million kilos) of end-of-use electronics.

Dell wanted to demonstrate the huge potential benefit of scaling up closed-loop plastics recycling. It commissioned research to assess the net environmental benefit of closed-loop recycled plastic in terms of lower pollution, reduced greenhouse gas emissions, and improved human health compared to using traditional plastic. This involved quantifying positive and negative environmental impacts and putting a monetary value on the result.

The results show that Dell’s current usage of closed-loop plastic has a 44% greater environmental benefit compared to virgin plastic, equivalent to an annual saving to society of \$1.3 million in avoided environmental costs. Of critical importance are the reduced human health and ecotoxicity impacts achieved by closed-loop recycling of plastic instead of disposal.

If all of Dell’s plastic was supplied by closed-loop recycling, the environmental benefit to society would increase to \$50 million per year. If the entire computer manufacturing industry switched to using closed-loop recycled plastic, the environmental benefit would increase to \$700 million per year (see figure).

FIGURE 3: ENVIRONMENTAL BENEFIT OPPORTUNITY THROUGH SCALING OF CLOSED LOOP RECYCLING



Assumptions:

35% closed-loop plastic, compared to 100% virgin plastic
 Added benefits from increasing computer recycling, to recover plastic

Dell's net benefit analysis helps make the case for increasing the use of closed-loop recycled plastic both within its own business and across the industry. By switching to a more environmentally beneficial way of manufacturing products in which plastic waste is valued as a useful resource, Dell and the computer industry can take a big leap forward towards sustainability.

"The key to success is to collaborate with stakeholders throughout the process," says Dell senior environmental engineer Puneet Shrivastava. "Dell brings all its 'environmental' stakeholders together in one room to discuss challenges and develop opportunities."

Initiatives such as Dell's closed loop recycled may start in the environmental team, but the challenge needs to be taken up by other people in the company such as marketing and procurement, as well as drawing on expertise from external partners.

One of the main continuing challenges is to get more end-of-use materials to recycle which meet the requirements of the new product. Again, collaboration provides the solution.

Dell regulatory engineer Stephanie Schafer says: "Conventionally, plastics in electronics may not be salvaged, with more economically attractive components such as hard drives, precious metals and chips driving the process. By working with partners to improve logistics, Dell have achieved a true 'closed loop' system."

OVERCOMING CHALLENGES TO SCALING SUSTAINABLE PLASTIC USE

Currently, many good practice initiatives are not being adopted more widely by industry because of financial barriers, technical challenges, infrastructure limitations and other obstacles. This section considers the key barriers faced in the transition towards a circular economy, the potential opportunities to overcome these, as well as the different players that are needed to do so.

OVERUSE OF DISPOSABLE PLASTIC DUE TO LOW VALUE

The current low cost and wide availability of plastics means that approximately 50% of plastics are used for single-use disposable applications, such as packaging, agricultural films and disposable consumer items⁶. Part of the solution to reduce the negative impacts of this is to ensure that plastic is valued and retained in products with long life and durability where possible and appropriate. Where this is not feasible, where single use is the only option for example, then steps should be taken to retain this material within the system after the end of first use.

ACCESS TO FEEDSTOCK

For any sustainable plastics system to be feasibly scalable, the supply of feedstock must be stable and consistent. When considering recycled material inputs, accessing feedstock can be a challenge. The low perceived value of plastics results in limited collection of material at end-of-use, with many countries having limited or no infrastructure for collection in place.

Collection infrastructure

Consumers have a role to play in terms of how and where they discard plastic at end-of-use. In countries that offer it, curbside recycling of plastic is typically dominated by packaging materials, particularly food and beverage containers. Consumers may lack awareness of all the other plastics used in the household that can be recycled, and where they can take it. Improved awareness raising is required to ensure that end users are knowledgeable about what can be recycled and where to do so. Local authorities, waste management companies and retailers/product manufacturers can all facilitate this through labeling of products and sites to ease access to recycling systems.

In addition, many countries in the world do not offer plastic recycling. If consumers are unable to conveniently recycle plastic at a curbside, then plastics may just simply be discarded into general waste and disposed of to landfill. Or worse, dumped into waterways or open-burned. Policy makers can play an important role in implementing new legislation to prevent this. Japan and some Scandinavian countries are among the best in the world in terms of plastics recovery, and a key differentiator is the legislation in place to reduce disposal to landfill. Japan achieves over 80% recovery rate of plastic, driven by laws requiring recycling or incineration of waste plastic due to lack of landfill space in the country¹⁵. In contrast, with few plastic recycling laws, the US achieves only a 9% plastics recycling rate (EPA, 2012). US regulatory frameworks are significantly different from Japanese, but while the same legislation may not be appropriate, improvements can be made to achieve better returns.

Landfill bans and taxes can be useful mechanisms to encourage recovery. European producer responsibility legislation, in which manufacturers take some responsibility for the recovery of their own products at end-of-use has also been valuable. According to Mike Biddle, founder of Closed Loop Polymers, this is the main reason the company operates in Europe, and not his home country of the US.

Waste management contracts

The awarding of contracts could be restructured. In the US, one stakeholder reported that recycling contracts are generally awarded in the same manner as landfill collection contracts – paying by the ton and not incentivizing quality. Policy makers could consider creating a revenue and cost share model, potentially making recyclers more resilient to fluctuating recycle prices and offering opportunity to get greater returns on valuable materials.

Decision making can be quite fragmented at a local authority/municipality level. Collaboration across regional representatives, and even at a wider global scale, would help create a more consistent system in which materials recovered are at a more uniform quality. This would also help facilitate global collaboration and sector-wide uptake.

Brand takeback

Another opportunity is to take back ownership of product recovery. In the Dell case study, it achieved success by establishing its own take-back scheme, encouraging recovery of plastic in its products. Depending on the type of product sold, opportunity may exist to have in store collection of goods and incorporate some level of return incentive, driving more customers to stores as well as clearly communicating brand sustainability. This cannot be achieved independently, however. Collaboration is key to establish links with both end processors and suppliers, and to ensure the smooth transition between stages of the lifecycle.

QUALITY OF END PRODUCT

Two key aspects were identified as challenges for the end product: the quality of input material if recycling plastics, and the change in physical properties of plastics when produced from varying plant-based inputs.

Changes in polymer characteristics

The first biopolymers had some functionality issues and were considered inferior to their fossil fuel-based counterparts and this perception still exists for some. For example, traditionally polylactic acid (PLA) has been considered to be too brittle and to have a lower heat deflection level (to maintain structure at higher temperatures) than fossil fuel based equivalents. But technological advancements means this is no longer the case for many biopolymers, often functioning at equal or above levels of the conventional counterparts. Further investment in research and development offers continued improvements in plastic functions.

Another argument given is that barrier functionality (in the prevention of microorganisms entering packaging) is lower in bioplastics, particularly with biodegradable plastics¹⁷. Developments in nanotechnology are overcoming these issues, and furthermore, other renewable, non-biodegradable plastics are more likely to perform at the level of their fossil fuel-based equivalents.

End users are advised to ensure that they are aware of the wide range of more sustainable plastics now on the market, and select polymers that are fit for purpose.

Feedstock quality in recycled plastics

There are many thousands of products made from plastic, each with individual chemical composition. Consistent quality in feedstock requires identification and separation of plastics which can be manually intensive and time consuming. Investment into technologies at material recovery facilities (MRFs) such as robotics and optical sorters, would improve the quality of post-consumer recycle.

Design for recyclability is important for manufacturers to consider, particularly in a true closed loop system, in which manufacturers take their own product back to recycle into the same product again. Moving to plastic production without the use of hazardous chemicals is a useful step to minimize harmful chemicals being passed forward in processing. By removing toxins in the original plastics, the value of the material at end-of-use is greater and companies are better placed to take back materials and recycle into new. Avoiding the design of products which are built with materials that are impossible to separate, ensuring the purity of plastic in the original product, and implementing systems to ensure products are returned, are all valuable steps to achieving closed loop.

FINANCIAL IMPLICATIONS

In recent years, many plastic recyclers have struggled or gone out of business due to cheap oil prices causing virgin plastic prices to drop significantly. While some successes do exist, these are fragmented, and generally do not utilize the economies of scale available to virgin plastic processors. In addition, competition from cheap recycling operational costs in China have made it easy for local authorities to export – in Europe for example, 87% of EU waste plastic is exported to China⁸. Manufacturers relying on recycle feedstock have therefore found the material harder to access, and sometimes more expensive than the virgin alternative. Conversely, this offers a benefit as well, as plastics manufacturers using recycle are protected from oil prices which are set to rise again.

Manufacturers that are not currently producing plastics with alternative feedstocks should focus on moving away from conventional oil supplies, focusing on possible benefits that can be achieved through use of renewable materials. By using recycled inputs or plant-based inputs, manufacturers protect themselves against oil price fluctuations that can be significant. Society's perception of plastics is deteriorating – an increasingly negative perception of plastics exists in society in relation to health, environment and other issues¹³. Companies utilizing these materials will be able to communicate their 'green' credentials and strengthen brand value, potentially increasing sales.

MARKET DEMAND

There is growing demand for sustainable plastic, but there are still some perceptions that need to be overcome to drive this up to a majority.

Resistance to change

Plastic users may be ill-informed of the availability of new materials, or, anecdotally, some manufacturers believe there is a simple aversion to change. Conventional plastics are well proven in their function, so companies may not wish to substitute a known input for an unknown one.

Raising awareness of alternative plastics and its innovations and achievements is still a key step to help encourage demand further. Industry experts recommend procurers educate themselves on new materials to understand the wide variety and capability of the many bioplastics available.

Cost of sustainable plastics

The low cost of oil in current conditions can result in very competitive conventional virgin plastic prices. This creates a reduced demand for sustainable plastics if the cost is higher. While cost is often one of the most significant purchasing criteria for plastic product manufacturers, wider benefits exist in the use of sustainable plastics, and these should be clearly highlighted to the sector to help drive demand.

Increasingly, investors are moving towards long-term environmentally sustainable investments, and decarbonizing their investment portfolios. The Portfolio Decarbonization Coalition (PDC) is a multi-stakeholder initiative mobilizing investors to decarbonize, and it currently oversees decarbonization of \$600 billion assets under management¹⁹. By investing in research and development of innovative recycling technologies and bioplastic development, investors can catalyze the scaling of sustainable plastics, helping to reduce costs and drive demand.

Markets for plastic recycling are developing rapidly, and investing now takes advantage of the environmental agendas of companies and individuals, plus security of supply allowing for a secure long-term return on investment.

Create a true price for plastic

A part of the solution may be a system change in the way society places value on products. Plastic is relatively cheap to buy, and therefore easy to discard. This does not consider the externalities – the costs borne by people outside the company producing the goods. By capturing a ‘true’ price of plastic, valuing the cost of pollution, GHG emissions, waste impacts and health implications associated with the production and consumption of plastic goods, society would value the material far more highly. Society is less likely to throw away assets that have value.

Limited end-user demand

Consumers are increasingly concerned about environmental issues, and effective communication of the environmental benefits of sustainable innovation in plastic use is likely to bring positive brand value.

Scientific assessment is important. Greenwash is often identified by consumers, media and NGOs, so robust analysis of all material impacts should be undertaken to market any claims made. Damage has been done to the reputation of sustainable plastics through the use of food crops as a raw material in some bioplastics, as well as examples of claims made with little evidence of value. It is also important to ensure plastic products are fit for purpose, and if designed for a specific end-of-use process (such as compostable plastics), then there needs to be the correct infrastructure in place to ensure this is the manner in which it is collected and processed. Brands and product manufacturers need to undertake assessments at the point of design, before products are made, to make sure that design decisions are correct.

SUMMARY

The value of plastics is undeniable. Innovations in technology demonstrates excellent opportunities to decouple growth in plastic use from environmental damage. But more needs to be done, and quickly.

The volume of waste plastic ending up in landfill, dumped in streets and eventually finding its way to the ocean is vast, yet the value of this 'waste' may be as high as the damage it can cause. Moving to a circular economy means changing our way of thinking away from 'dealing with plastic waste' and towards capturing the value of this important feedstock.

Many opportunities exist to encourage the scaling up of sustainable plastic use to an industry-wide activity, but the key is communication and collaboration. To build upon the positive examples of sustainable plastic, systemic change is needed. The sector needs a global, multi-pronged approach incorporating stakeholders from across sectors, targeting infrastructure, design and value.. The table overleaf summarizes the main solutions to overcome the key challenges, and the actions needed by stakeholders.

The table shows that challenges are not independent of each other – for example, improving infrastructure will reduce costs, making practices more financially viable, potentially increasing competitiveness and driving demand. It also shows that there is no single action that will achieve systemic change.

However, one theme is constant. The market does not currently value plastic in a manner that reflects the true cost of all the natural capital impacts and dependencies that it has. These costs are generally not paid by the companies that manufacture and use plastics, but by the communities in which the impacts are felt, and wider society as a whole. If society paid the true price for virgin, fossil fuel-based plastic, then the true value of a circular economy would be clear.

CHALLENGE	PLASTIC	RELEVANT STAKEHOLDER	CAUSE	SOLUTION	STAKEHOLDERS
Access to feedstock	Recycled plastics	Recyclers/ manufacturers	Low perceived value of plastic	Consider ‘true pricing’ – monetizing externalities of plastic production, consumption and disposal	All
			Low collection of plastic at end-of-use	Producer responsibility legislation	Policy makers
				Improved access to recycling facilities/ curbside collection	Policy makers
				Direct takeback of product –taking ownership of recovery	Retailers/ product manufacturers
	Biopolymers	Plastics manufacturers	Large scale plant matter from responsible sources	Incorporate industrial waste product – such as lignin, waste from pulp and paper sector.	Investors Academics/Researchers
Quality of end product (real)*	Biopolymers	Plastics manufacturers	Some bioplastics are reported to be inferior in some qualities	Continued innovation and development	Investors Academics/Researchers
	Recycled		Low quality feedstock can jeopardize quality in end product	Improve design for recycling/reuse	Original product and plastics manufacturers
Financial issues	Biopolymers and recycled	Recyclers/ manufacturers	Cheap oil commodity prices	Raise awareness of other financial benefits – stability of feedstock, brand value, protection against future legislation	All
	Recycled		Low volumes of processed material	Develop infrastructure to achieve economies of scale at each step of value chain	
Market demand	Biopolymers and recycled	Recyclers/ manufacturers	Distrust of benefit claims	Avoid greenwashing by ensuring benefit of product is scientifically and robustly calculated. Use a holistic assessment that considers potential trade-offs.	Academics/Researchers Manufacturers (plastic and product)
			End customer not aware	Educate end consumers of the benefit of sustainable plastics to help drive demand	NGOs Policy makers
			Quality of end product (perceived)	Improved marketing and awareness raising, as well as continued development where issues do exist	Policy makers Manufacturers
			Higher costs of plastic	By improving technical issues faced in the above issues, cost of production of sustainable plastics will be reduced, allowing for more competitive end pricing also.	All

*It is important to differentiate between some existing quality issues that have been observed during robust testing of plastics, and a perceived inferiority of product that appears to exist due to historical performance challenges, and changes to smell and the aesthetics of the plastic during processing that may make users hesitant to trust in the product.

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