Special Report:

Managing Plastics in a Sustainable Way – A Global Necessity

The Ellen MacArthur Foundation

Editor's Note:

Plastic is everywhere, but insufficient thought is given to what happens after it is discarded. Most plastic is considered waste after its first, brief use. In the absence of an efficient recapture process, plastic "leaks" into the environment, most notably into the oceans, and creates damage far exceeding its original value. Plastic should be managed as a precious commodity because its cost skyrockets when allowed to occupy natural environments. Plastic in the environment is a big and complicated problem – the solution also is big and complicated.

The Ellen MacArthur Foundation, in partnership with the World Economic Forum and McKinsey & Company, proposed the implementation of a circular plastics economy to deal with these issues. Their roadmap to creating a sustainable lifecycle for plastic packaging is described in The New Plastics Economy: Rethinking the Future of Plastics.

This Renewable Natural Resources Foundation (RNRF) Special Report summarizes the key ideas and concepts of the New Plastics Economy.

I. Introduction

The New Plastics Economy detailed an approach for managing plastics through a circular economy. A circular economy is built on the concept of eliminating waste and pollution; keeping materials and products in use, rather than discarding them; and regenerating natural systems. Essentially, a circular approach deals with a product or material, in this case plastics, throughout its entire lifecycle. The New Plastics Economy emphasized the need to establish this circular economy to provide a future for plastic beyond its initial use.

Plastics are an integral part of modern society. Over the last 50 years plastics production has drastically surged, "from 15 million tonnes in 1964 to 311 million tonnes in 2014, and is expected to double again over the next 20 years, as plastics come to serve increasingly many applications."[1] Plastics provide unparalleled utility to our everyday lives but plastics also come with environmental and human health impacts that must be remedied. It is estimated that "at least 8 million tonnes of plastics leak into the ocean each year[2] – which is equivalent to dumping the contents of one garbage truck into the ocean per minute."[3] Much of the plastic that makes its way into the ocean breaks down into harmful microplastics that are ingested by marine animals. Plastics also significantly contribute to climate change through greenhouse gas emissions during production and are composed of substances that may contain substances harmful to human health and the environment.

II. New Approach Required to Implement the New Plastics Economy

The transition to the New Plastics Economy will need to be built on existing improvement initiatives and steered by the creation of an independent coordinating vehicle. This vehicle would aim to "stimulate development of a circular economy approach to plastics and plastic packaging as an integral part of the future economy. It would also aim for positive broader economic impacts and – directly

[1] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, *The New Plastics Economy: Rethinking the future of plastics* at 17 (2016, https://www.ellenmacarthurfoundation.org/publications).

[2] J. R. Jambeck et al., Plastic waste inputs from land into the ocean (Science, 13 February 2015).

[3] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 29.

or indirectly – to the protection and restoration of natural systems."[4] Consumer goods companies, plastic producers and manufacturers, cities and businesses involved in after-use infrastructure, policymakers and NGOs all have a role to play in the New Plastics Economy. For example, policymakers could help to drive the transition through incentives and fostering secondary markets and innovation, while the NGO community could help to guarantee that social and environmental concerns are evaluated. Collaboration is essential to overcome the fragmentation within the plastics economy and bring about the New Plastics Economy.

III. The New Plastics Economy

The New Plastics Economy is built on the concept of a circular economy meaning, as the name connotes, a looped system that is designed to be restorative and regenerative. A key principle of the New Plastics Economy is that "products and materials are circulated at their highest value at all times."[5] The three pillars of the New Plastics Economy include: (1) creating an effective after-use plastics economy through improved recycling, reuse and targeted compostable packaging, (2) drastically reduce plastic leakage into natural ecosystems (e.g. the ocean), (3) decouple plastics from fossil fuels through dematerialization and employing renewably-sourced plastics from biomass and/or captured greenhouse gases.

i. Creating an Effective After-Use Plastics Economy

The first priority of the New Plastics Economy is to establish an effective after-use plastics economy by improving the economics and uptake of recycling, reuse and targeted compostable packaging.

a. Recycling

To date, only 14% of plastic packaging is gathered for recycling. And of the plastic that is recycled, most is down-cycled into a lower value product that cannot be economically recycled again. It is estimated that "about 95% of plastic packaging material value, or US $80-120 billion annually, is lost to the economy after a short first-use cycle."[6] The New Plastics Economy sees this as an economic opportunity for industry to capitalize on by implementing five levers of change described below.

1. Establish a Cross-Value Chain Dialogue Mechanism

In order to remedy the disjointed plastics recycling process there must first be the ability to communicate among all parties involved, namely there must be a global cross-value chain dialogue mechanism. This mechanism would require actors from each step of the global value chain – from refining to reprocessing – to coordinate and communicate to overcome the fragmented processes and steer coordinated action. Coordination and communication are key to enacting largescale improvements to recycling worldwide.

2. Develop a Global Plastics Protocol to Set Direction on the Redesign and Convergence of Materials, Formats, and After-Use Systems

The current plastics economy is extremely fragmented due to a lack of unified standards and coordination across the value chain. As a result, there are inconsistent global plastic packaging designs as well as collection and sorting practices. The New Plastics Economy advocates for the creation of a protocol that would provide guidance on labeling, design, marketing, after-use infrastructure and secondary markets to bring uniformity to this process while allowing for innovation and regional differences.

The New Plastics Economy recommends that these plastic packaging design guidelines be industry-driven, global, flexible and coordinated with the development of after-use infrastructure. Global design guidelines could also provide a basis for policymakers to increase incentive measures. For example, in France "fees [that are] paid into the Extended Producer Responsibility compliance mechanism can reflect penalties for designs that are

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[4] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 39.

[5] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 47.

[6] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 46.

known to impede high-quality recycling (e.g. PET bottles with PVC or aluminum labels or caps)."[7] Using global design guidelines would create uniformity for producers and avoid the confusion of having to adhere to numerous regional regulations.

To start, design guidelines could be focused on replacing certain design and material elements that are harder to recycle. The idea would be to replace these problems materials/designs with existing alternatives that have a higher chance of recyclability without seriously impacting costs and performance of the product. An example of this is PVC, which can inhibit recycling, and already has existing alternativities for a majority of its packaging applications.

Design guidelines would need to be aligned with the global guidelines for after-use systems in order to be successful. This synergistic approach would enable innovation in sorting, labeling and other technologies to rapidly scale up and allow people to uniformly sort their plastics more easily. Cities and businesses involved in after-use infrastructure (e.g. collection and sorting) would also benefit from the economies of scale and could share best practices across the industry.

Collection and sorting guidelines need to be built on two basic principles: (1) source separation and, (2) comprehensive collection. Source separation simply means that biological cycle materials and technical cycle materials need to be dealt with differently – they must be separated. This separation can take place at the sources (i.e. household bins) or later in designated sorting facilities. Source separation improves the quality of recycling by avoiding contamination between biological and technical cycle materials during collection.

Currently, the collection systems of many countries are focused on collecting certain plastic packaging that have developed recycling markets, while the remaining plastic packaging becomes waste. This lack of comprehensive collection and sorting infrastructure creates an impasse to design improvements. There is no incentive to design recycle-focused products or develop reprocessing infrastructure when there is no way to effectively collect and sort the materials. The New Plastic Economy suggests that coordinated cross-value chain action could help overcome this impasse.

3. Focus on Key Innovation Opportunities That Have the Potential to Scale Up

Technological innovation is needed to achieve drastically better recycling rates, quality and economics. Collaboration and coordination from industry is integral to fulfilling this potential for improved recycling. Namely, there needs to be design innovation for improved recycling ability without comprised functionality such as investments in new or improved materials, sorting and reprocessing as well as improved mechanical and chemical recycling processes.

4. Enable Secondary Markets for Recycled Materials

The transition to the New Plastics Economy could be accelerated by creating a secondary market for recycled materials. In order to achieve his goal, there would need to be enhanced transparency to better match supply and demand as well as strengthening the "pull effect" on the demand side. The "pull" effect could be strengthened through a combination of industry commitments and policy decisions.

Transparency in material composition and specifications is extremely important and helps to better facilitate matchmaking between supply and demand. This better matchup could be achieved by introducing and scaling up matchmaking mechanisms. For example, an aggregator software or platform could be used to match recyclers and companies that sources recycled content.

The "pull" effect, meaning one that is intended to create demand for a product, could be strengthened for plastic packaging through voluntary industry measures or policy-driven. Creating demand for plastic packaging through the "pull" effect could expedite the transition to an after-use plastics economy. For example,

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[7] INSEAD, Extended Producer Responsibility: Stakeholder Concerns and Future Developments (2014); http://www.ecoemballages.fr/

manufacturers and/or companies could voluntary commit to using recycled material in their products, thereby generating a significant demand for recycled plastics. On the policy side, a law that imposes mandatory use of recycled materials could be implemented or incentives such as tax advantages or rebates on Extended Producer Responsibility contributions could be used. Extended Producer Responsibility refers to the approach where producers are required to take more responsibility, financially and/or physically, for the treatment or disposal of their products.

5. Explore the Enabling Role of Policy

Policymakers have the ability to play an integral role in allowing businesses and local governments to overcome the barriers to an effective recycling economy. In addition to the pull measures, discussed above, policymakers could also explore policy-focused measures. Potential measures include imposition of a carbon tax or bans on landfilling/incinerating as well as implementation of Extended Producer Responsibility schemes.

b. Reuse

Reuse has an integral role to play in the circular plastics economy. The New Plastics Economy asserts that reuse has value in both business-to-business (B2B) and business-to-consumer (B2C) applications. B2B applications could include individual company adoption of reuse systems as well as shared-asset systems such as the "physical internet." B2C applications involve user-centric models that focuses on the willingness of the consumer to be part of the reuse cycle.

Adopting reusable packaging in the B2B setting can provide significant material savings when compared to the disposable option and reduce a company's carbon footprint. If this system is effectively standardized across the board and shared among companies, reusable packaging could help to address waste in the logistics sector and create significant value beyond just material savings. B2B could take place on several different scales including through individual adoption (via a single retailer or brand), single-industry pooling (a reuse system that offers reusable packaging as a cost savings service to companies in a single industry) or multi-industry pooling (offering a reuse system on a larger scale across different industries). An advanced large-scale reuse system could take the form of the "physical internet."

The "physical internet" is a logistics system based on standardized, modularized, shared assets. The three pillars of this vision are (1) reuse – via standardized, modular, reusable, recyclable containers (2) share – via open networks with pooled assets and protocols, and (3) virtualize – employ IT infrastructure that allows real-time tracking. "Unlike the conventional approach of owning and optimizing assets, participants in the Physical Internet aim to optimize delivery of the product, using available assets regardless of ownership."[8] The New Plastics Economy report states that a transition to the "physical internet" could "unlock significant economic value — estimated to be US $100 billion and a 33% reduction in CO_2 emissions annually in the United States alone."[9]

B2C business models rely on the willingness of users to partake in reuse systems. This could include business models that take advantage of their user's willingness to reuse in the home (e.g. using refillable cleaning products) and user-centric reusable packaging in stores (e.g. allowing and encouraging customers to bring in their own containers and use self-service weighing machines for certain goods). The application of the "physical internet" is more challenging in the B2C setting but could be employed for specific targets such as plastic bags.

c. Targeted Compostable Packaging

Most biological nutrients in plastic packaging are either sent to landfills or incinerated. In the United States, the largest element of municipal waste in landfills is uneaten food. Compostable plastic packaging for targeted

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[8] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 65.

[9] R. Meller et al., From Horizontal Collaboration to the Physical Internet: Quantifying the Effects on Sustainability and Profits When Shifting to Interconnected Logistics Systems, Final Research Report of the CELDi Physical Internet Project, Phase I (2012).

applications could return this organic material to the soil, if deployed in conjunction with proper collection and recovery infrastructure. In order to make this happen compostable packaging must meet two criteria: (1) the packaging is prone to being mixed with organic content, and (2) compostable materials and recycle materials follow different after-use pathways. This second criterion is crucial because compostable packaging can interfere with the recycling process. Examples that meet both criteria include teabag packaging, coffee capsules and bags for organic waste. In order to execute this properly, requisite industrial composting and anaerobic digestion (the breakdown process that occurs in the absence of oxygen) infrastructure must be in place. Deploying compostable packaging could make a huge difference in reducing food waste worldwide.

ii. Drastically Reduce Plastic Leakage in Natural Ecosystems and Associated Negative Impacts

The New Plastics Economy aims to address plastic packaging issues by focusing on reducing plastic leakage and highlighting issues with certain substances in the composition of plastics.

a. Leakage

It is estimated that over 30% of plastics leak out of the collection system worldwide. Approximately 8 million tonnes of this leaked plastic, the majority of which is plastic packaging, leaks into the ocean every year. These plastics do not breakdown quickly but remain for hundreds of years causing harm to natural ecosystems as well as economic costs that range into the billions.

The New Plastics Economy offers a solution to this leakage by drastically improving after-use infrastructure in high-leakage countries. This improvement alone, however, is not enough. The economic attractiveness of keeping plastics within the system needs to be increased. Meaning, the effort it takes to collect and recycle plastics should be made worth the trouble. This can be achieved by creating an effective after-use plastics economy through recycling, reuse and targeted composting (as described above), which would get to the root cause of leakage.

Additionally, innovation needs to be steered towards bio-benign materials that reduce the negative environmental impacts of plastic packaging pollution. “Today’s plastic packaging offers great functional benefits, but has an inherent design failure: its intended useful life is typically less than one year; however, the material persists for centuries and can be damaging if it leaks outside collection systems.”[10] While plastic leakage into the environment could be greatly reduced it is unlikely that leakage will be eliminated entirely. “Even in the case that leakage of plastic packaging could be reduced globally from 32% to 1%, about 1 million tonnes of plastic packaging would still escape collection systems and accumulate in natural systems each year.”[11] Development of bio-benign plastics is greatly needed but faces innovation challenges because this product must also be cost-effective and the ability to scale up to be a viable alternative.

b. Substances of Concern

Plastics are made up numerous substances, some of which are reason for concern. There is uncertainty regarding the long-term impacts of exposure to this material on human health and the environment, namely the ocean. The New Plastics Economy suggested that further research and development of safe alternatives is warranted to capture value by using materials that are safe in all product phases.

iii. Decouple Plastics from Fossil Fuel Feedstocks

The New Plastics Economy advocates for a decoupling of plastics from fossil fuels through the use of dematerialization and renewably sourced plastics.

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[10] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 77.

[11] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 77.

a. Dematerialization: Doing More with Less Plastic

Dematerialization is "the act of reducing or even eliminating the need for packaging, while maintaining utility."[12] The New Plastics Economy deploys three levers to utilize dematerialization of plastic packaging. These three levers include: (1) light-weighting – the process of reducing the mass of the packaging, (2) rethinking packaging design, and (3) virtualization – the act of delivering utility virtually.

The light-weighting process, while advantageous from a material savings standpoint, has an undesirable side effect for recycling. Reducing the material used through light-weighting may actually lead to more leakage because the product is now less valuable for recycling purposes.

Rethinking packaging design can capture economic value while reducing plastic packaging volume. Moreover, modern consumers are increasingly aware of over-packaging and prefer to buy concentrated products to avoid the excess plastic packaging. Companies could take advantage of this trend to their economic benefit.

Virtualization could drastically reduce the need for plastic packaging. Virtualization examples include those "in which utility is (partly) delivered virtually include the widespread use of digital music, movies and books, as well as emerging additive manufacturing technologies, commonly known as 3D printing, all of which change the requirements and necessity of packaging."[13]

b. Renewably-Sourced Plastics: Decoupling Plastics Production from Fossil Feedstocks

Plastics need to be decoupled from finite resources (i.e. fossil feedstocks) by sourcing plastics from renewable sources. Renewably-sourced plastics could be produced from captured greenhouse gases (i.e. methane and carbon dioxide) or biomass (bio-based). Methane and carbon dioxide can be captured from numerous sources. Methane can be recovered from anaerobic digesters, landfills or coal mines while carbon dioxide can be recovered as a by-product of industrial and chemical processes (e.g. petrochemical production or oil and gas processing). In addition to reducing the use of finite resources, using renewably-sourced plastics could greatly reduce carbon emissions and potentially act as a carbon sink throughout their life cycle.

While bio-based plastic presents an exciting opportunity, it is not currently cost-competitive with fossil-based plastics. Likewise, GHG-based plastics viability at scale has yet to be seen. Research and innovation in these areas are needed to make renewably-sourced plastics a reality.

IV. Conclusion

Overall, the New Plastics Economy provides a roadmap for a fundamental rethinking of how we deal with plastics. While many elements of this proposal will be difficult to implement, the report aims to be the spark that spurs change. One day this transformation could take place, ushering in the New Plastics Economy.

Read more about *The New Plastics Economy: Rethinking the Future of Plastics*: here.

[12] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 88.

[13] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 90.