U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON RESEARCH & TECHNOLOGY
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HEARING CHARTER

Plastic Waste Reduction and Recycling Research:
Moving from Staggering Statistics to Sustainable Systems

Thursday, June 24, 2021
10 a.m. ET
Zoom

PURPOSE

On Thursday, June 24, 2021, the Subcommittee on Research and Technology of the U.S. House of Representatives Committee on Science, Space, and Technology will hold a hearing titled, *"Plastic Waste Reduction and Recycling Research: Moving from Staggering Statistics to Sustainable Systems."* The purpose of this hearing is to discuss federal research and development and standards development needs to help address the plastic waste crisis and barriers to the current recycling system. In addition, the Subcommittee will explore challenges and opportunities for adopting sustainable upstream plastic waste reduction solutions and efficacy of existing lifecycle analysis models for assessing the impact of plastic waste and metrics for sustainability. The Subcommittee will also consider the role that the *Plastic Waste Reduction and Recycling Research Act* can play in addressing these important issues.

WITNESSES

- **Ms. Keefe Harrison**, Chief Executive Officer, The Recycling Partnership
- **Dr. Marc Hillmyer**, Director and Principle Investigator, University of Minnesota National Science Foundation Center for Sustainable Polymers
- **Dr. Gregory Keoleian**, Director, Center for Sustainable Systems, Peter M. Wege Professor of Sustainable Systems, School for Environment and Sustainability Professor, Civil and Environmental Engineering, co-Coordinator, Engineering Sustainable Systems Program, University of Michigan
- **Mr. Joshua Baca**, Vice President, Plastics Division, American Chemistry Council

OVERARCHING QUESTIONS

- How has the plastics waste stream changed since the mid-1900s? How has plastics recycling changed since the 1970s? What are the barriers to the current plastics recycling system and increased recycling rates? What are the roles of upstream and downstream plastic waste reduction solutions in meeting our long-term environmental sustainability goals?

- What research, development, and standards are needed to advance innovation to support upstream and downstream solutions to reduce plastic waste and increase recycling rates? What models are needed to help in decision-making and assessing sustainability of different solutions?
- What is the role of federal science agencies in supporting research and development in plastic waste reduction solutions? What is the role of the private sector? How can public-private partnerships support innovation in plastic waste reduction and reduce the environmental impact?

Overview of U.S. Plastics Production and the Plastics Recycling System

Plastics manufacturing and production grew exponentially during and after World War II. The OECD estimates that global production of plastic increased from two million tons of plastic per year in 1950 to more than 400 million tons per year today.[1] Current low oil prices make virgin resin less expensive to produce than using recycled content. In 2016, the U.S. generated the largest amount of plastic waste of any country in the world.[2] Furthermore, plastic production is expected to quadruple by 2050.[3] Of the 8.3 billion metric tons of plastic that has been produced globally, 6.3 billion metric tons has become plastic waste.[4] Nine percent of this plastic waste has been recycled, 12% has been incinerated, and 79% went to landfills or accumulated in the environment.[5]

The environmental movement of the 1970s introduced the concept of Reduce, Reuse, Recycle. To address concerns about mounting municipal and industrial waste, the *Resource Conservation and Recovery Act of 1976* (RCRA), authorized activities, including research and development (R&D) for the recovery of materials from landfills, including petroleum-based resources. Ninety-nine percent of plastics are composed of fossil fuel based chemicals made from oil and natural gas. This national effort prompted growth of the U.S. plastics recycling industry in the 1980s for both post-consumer and post-industrial plastics. However, as the U.S. recycling market was growing, U.S. recycling infrastructure did not keep pace with domestic plastic production.

China's steadily growing recycling industry became a competitive market for post-consumer plastics from the U.S. For more than two decades, the U.S. and other developed nations sold and

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[1] OECD, *Improving Markets for Recycled Plastics: Trends, Prospects and Policy Responses,* 2018. http://www.oecd.org/env/waste/improving-markets-for-recycled-plastics-9789264301016-en.htm

[2] Lavender Law, Kara, et al, "The United States Contribution of Plastic Waste to Land and Ocean," Science Advances, October, 30, 2020.

[3] https://www.ellenmacarthurfoundation.org/assets/downloads/EllenMacArthurFoundation_TheNewPlasticsEconomy_Pages.pdf

[4] Geyer, R., Jambeck, J. R., & Law, K.L., "Production, Use, and Fate of All Plastics Ever Made," Science Advances, 2017.

[5] *Id.*

exported 106 million metric tons of recyclable plastics to China.[6] In 2018, China implemented a policy to prohibit the purchase of most U.S. plastics collected for recycling because of high contamination levels. Effective January 1 this year, new international restrictions on trade in plastic waste were implemented under the Basel Convention, including restrictions on non-Parties such as the United States.[7] The immediate effects of the 2018 ban meant that some communities that once recycled no longer had access to an affordable materials recovery facility (MRF) that would purchase and process their items collected for recycling. Therefore, more and more communities sent recyclable items to landfills or incinerators as a less expensive means of disposal. That same year, 35.7 million tons of plastic were generated in the U.S., of which 3 million tons were recycled, 5.6 million tons were combusted, and 27 million tons were landfilled, making up 18% of all municipal solid waste in landfills in 2018.[8]

Federal Plastic Waste Reduction R&D

Several federal agencies carry out R&D and standards development programs related to plastics recycling, material substitutes, and data gathering. However, there is not a coordinated effort to leverage the whole of the federal R&D enterprise to address the challenges of recycling and reducing plastic waste.

In addition, while some plastics have established markets for recycling, there are no national standards for processing plastic recycling. Congress has long been concerned about the permanency of plastic in the environment and the role of R&D and standards in finding solutions, including degradable plastics and recycling. A 1988 U.S. General Accounting Office (GAO) study found that the federal government and the private sector were only making limited efforts in R&D expenditures and development of standards for degradable plastics.[9]

Another GAO report in 2007 reiterated that EPA and the Department of Commerce have legal responsibilities for encouraging recycling and recommended that the Department of Commerce develop and implement a strategy to stimulate the development of markets for recycled materials in the U.S., including identification of technical barriers to the use of recycled materials. However, the government's position at the time was to continue efforts to support increased international trade in recycled and recyclable materials.[10]

Most recently, a 2020 GAO study reviewed federal efforts to advance recycling and found these five cross-cutting challenges to the U.S. recycling system: 1) contamination of recyclables; 2) low collection of recyclables; 3) limited market demand for recyclables; 4) low profitability for

[6] Watson, Sara Kiley, "China Has Refused to Recycle The West's Plastics. What Now?," NPR, June 28, 2018. https://www.npr.org/sections/goatsandsoda/2018/06/28/623972937/china-has-refused-to-recycle-the-wests-plastics-what-now

[7] https://www.epa.gov/hwgenerators/new-international-requirements-export-and-import-plastic-recyclables-and-waste#fq5

[8] https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/plastics-material-specific-data

[9] https://www.gao.gov/assets/rced-88-208.pdf

[10] https://www.gao.gov/assets/gao-07-37.pdf

operating recycling programs; and 5) limited information to support decision-making about recycling.

The first challenge of contaminated recyclables is a key issue and an important area for potential research. Advanced screening technologies are needed to better separate plastics for recycling because manufacturers are increasingly making resins using many different chemical compositions and multilayered packaging. Contamination of recyclables happens when non-recyclables are not sorted from recyclables or when food residue on plastic materials makes them non-recyclable. Non-recyclables can include film plastics such as plastic bags and some food packaging. The contamination of recyclables raises two important issues. First, the ability to identify what is recyclable and second, the ability to separate non-recyclables from recyclables.

Concerning identification of recyclables, one common technology used for sorting plastics is an optical scan using infrared light to detect what an item is and its chemical composition. In the 1980s, industry developed resin identification codes (RICs) for plastic products. These are commonly identified on packaging by a number 1 through 7 in a triangle made of three arrows, very similar to the three sided "Reduce, Reuse, Recycle" symbol. However, RICs neither indicate recyclability nor do they necessarily identify the exact chemical composition of a product. Manufacturers of two different brands may design similar packaging with the same RIC, but each container or package may have a slightly different composition.[11] The recycling challenge is that the chemical make-up for some products is so different that the plastics will not mix or cannot be mixed because of the risk of a chemical reaction or explosion. The National Institute of Standards and Technology (NIST) is supporting a new Center for Materials and Manufacturing Sciences that focuses on polymers and polymer recycling research in areas including analysis, processing, and testing. This Center's research will help support standards development for key areas.

Concerning the ability to separate non-recyclables from recyclables, most plastics recycling today is done through a process of mechanical recycling. This process can involve sorting, cleaning, cutting, melting and compressing post-consumer and post-industrial plastics into a raw material for making a new product. Some experts believe this will continue to be the predominant process for most plastics well into the future. However, some mechanical recycling infrastructure is decades old and not built to process today's volumes and types of resin-based, multilayered plastic products, such as plastic grocery bags and other film plastic. There currently are specialized recycling facilities for these plastics. Yet, in the recycling process they lose characteristics such as durability and food-grade safety, making them incapable of being used for their original use; therefore, they are downcycled and turned into low value products.

[11] The RIC is an identifier of the general chemical composition of a product – e.g. "1" identifies PET, "2" identifies High-Density Polyethylene (HDPE) used in products including milk and laundry detergent bottles, "3" identifies Polyvinyl Chloride (PVC) used in products including shrink wrap and construction pipes, and so on. https://plastics.americanchemistry.com/Plastic-Resin-Codes-PDF/

For plastics that lose value or are difficult to break down using mechanical recycling, a solution may be chemical recycling, also known as advanced recycling or depolymerization. This process breaks down a polymer to its building blocks resulting in a quality similar to virgin resin. This is referred to as upcycling. Chemical recycling enables recyclers to extrude each type of polymer from an item or introduce an element that will make the resins compatible for combined recycling. Some do not support advanced recycling research and have expressed concerns regarding advanced recycling, including the cost to construct the facilities, the amount of energy it takes to operate them, the potential that recyclables will be turned into fuel rather than feedstock for new products, and that it is so far an unproven technology that has not successfully recycled at commercial scale. In May 2021, Department of Energy (DOE) announced investments up to $14.5 million for R&D to cut waste and reduce the energy used to recycle single use plastics, the largest subset of plastics in landfills.[12] This investment leverages DOE's funding of basic and applied research in plastics recycling and bioplastics at universities and national laboratories, including through its funding of the Reducing EMbodied-energy And Decreasing Emissions (REMADE) Institute, part of the Manufacturing USA® network.

Upstream Solutions to Plastic Waste

A recent study concluded that by using current knowledge and technologies to implement all feasible plastic waste reduction interventions, plastic waste pollution could be reduced in 2040 by 40% from 2016 rates and by 78% relative to current commitments, or "business as usual."[13] These interventions include reducing plastic consumption; increasing rates of reuse, waste collection, and recycling; expanding safe disposal systems; and accelerating innovation in the plastic value chain.[14] However, the researchers also stated that a large amount of plastic waste would accumulate in the environment even with a 78% reduction in plastic pollution. Therefore, the study recommended that further innovation is needed in resource-efficient business models, reuse and refill systems, sustainable substitute materials, waste management technologies, and effective government policies.[15]

Experts agree that designing materials for recyclability will be key. The National Science Foundation funds research in sustainable polymers and renewable materials that can substitute for petroleum-based plastics. NSF, DOE, Department of Agriculture, and other federal agencies support sustainable materials research which offers a non-petroleum based material alternative for some applications, such as films for food products. Challenges for current biobased plastics are their biodegradability and incompatibility with existing recycling infrastructure. Biobased plastics are only biodegradable in industrial composting facilities, not landfills. In addition, biodegradable plastics are a source of contamination when mixed with plastic recyclables.

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[12] https://www.energy.gov/articles/doe-announces-145-million-combat-plastics-waste-and-pollution

[13] Winnie W. Lau, et al., "Evaluating scenarios toward zero plastic waste pollution," Science, September 18, 2020, Vol. 369, Issue 6510, pp 1455-1461. https://science.sciencemag.org/content/369/6510/1455.full?ijkey=jGXwX4eBf.mws&keytype=ref&siteid=sci

[14] *Id.*

[15] *Id.*

In addition to material substitutes, reuse/refill systems are another upstream solution. Buying in bulk, refillable packaging, and returnable packaging have existed for a long time. However, further social, behavioral and economic research is needed into understanding the opportunities and barriers to wider implementation, including impacts to supply chain, as well as design and development of decision support models.[16]

The Plastic Waste Reduction and Recycling Research Act

On June 15, 2020, Representative Haley Stevens, Chair of the Research and Technology Subcommittee of the House Committee on Science, Space, and Technology, first introduced this bipartisan bill cosponsored by Representative Anthony Gonzalez, Chairwoman Eddie Bernice Johnson, and Ranking Member Frank Lucas. The bill was reintroduced this Congress on Earth Day, April 22, 2021. It supports increasing federal investments in plastic waste reduction and recycling R&D, recycling standards development, and other activities. Below is a high-level summary of the bill.

Summary: The bill directs the Director of the Office of Science and Technology Policy to establish a program to improve the global competitiveness of the United States plastics recycling industry, ensure U.S. leadership in plastics waste reduction, reuse, and recycling research, ensure U.S. leadership in national and international standards development, and reduce any harmful effects of plastic waste and plastic waste recycling on the environment. The bill also calls for the establishment of an interagency committee to coordinate the program, develop definitions for key terms, including "recycle" and "recyclability", and develop a strategic plan for plastic waste reduction and recycling and plastic waste remediation.

Finally, this legislation authorizes R&D and other activities at five federal agencies. The bill directs NIST to carry out research and provide the metrology basis for standards development for plastics recycling and develop a clearinghouse to support dissemination of tools, guidelines, and standards. The bill also directs NSF to support interdisciplinary research and curriculum development on plastic biodegradation, compostable plastics, environmental effects of plastic waste relevant to plastics recycling, and barriers to expanding plastics recycling. In addition, the bill authorizes continued support for activities at DOE, including new recycling technologies, designing for recyclability, and upcycling recycled plastics into new high value products. Finally, the bill supports research and other activities at EPA on innovative plastic waste management and supports research at the National Oceanic and Atmospheric Administration (NOAA) on remediation of plastic marine debris and ocean plastic pollution.

The bill authorizes funding for five years and invests $85 million in fiscal year 2022 with a 6.5% annual increase for these activities.

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[16] Patricia Megale Coelho, *et al.*, "Sustainability of reusable packaging- Current Situations and Trends," Science Direct, Vol. 6, May 2020, 100037 - https://www.sciencedirect.com/science/article/pii/S2590289X20300086#!