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مركز الملك عبدالله للدراسات والبحوث البترولية

King Abdullah Petroleum Studies and Research Center

Instant Insight

The Role of Circular Economy for Plastic Waste Management

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KAPSARC is an advisory think tank within global energy economics and sustainability providing advisory services to entities and authorities in the Saudi energy sector to advance Saudi Arabia’s energy sector and inform global policies through evidence-based advice and applied research.

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Introduction

In March 2022, in Resolution 5/14, the United Nations Environment Assembly requested that the UN Environment Programme set up an Intergovernmental Negotiating Committee to develop an international legally binding instrument on plastic pollution, which included the marine environment (UNEP 2022). At the ongoing INC meetings, the circular plastic economy model was identified as an essential measure for eradicating plastic pollution. Consequently, UNEP established a secretariat for the INC and developed a negotiation schedule to comprise five sessions of INC meetings where member states, International Governmental Organizations, non-governmental organizations, observers, businesses and associations and other stakeholder organizations agree on a global treaty on plastic pollution, which includes pollution of the marine environment.

To date, three INC sessions have been completed. The first INC session, INC-1, was held in Punta del Este, Uruguay, from November 28 to December 2, 2022. The INC-1 set up membership for elective committee positions in addition to establishing processes and procedures for the meeting sessions; INC-2, held in Paris, France, from May 29 to June 2, 2023, discussed the elements of the treaty, such as its objectives and substantive obligations, as well as the means for implementing the treaty. Due to time constraints and to allow for input from interested participating member states and observers, the INC secretariat encouraged the submission of emailed statements during and shortly after the meeting. These were then incorporated into a zero draft of the treaty for consideration at INC-3. From November 13 to 19, 2023, INC-3 was held in Nairobi, Kenya. Importantly, over the course of the negotiations, plastic circular economy has been a recurrent quest of various stakeholders for inclusion as an essential element of the treaty. One of the thematic events at INC-3 was “promoting circular economy to retain plastics in the economy and out of the environment, including innovation and expanding the share of circular plastics” (UNEP 2023). Under this theme, issues concerning plastic waste material life cycle and potential frameworks for plastic circularity were discussed. The King Abdullah Petroleum Studies and Research Center, a UNEP observer organization, participated in those discussions affirming the view that a circular economy model is essential for plastic waste management.

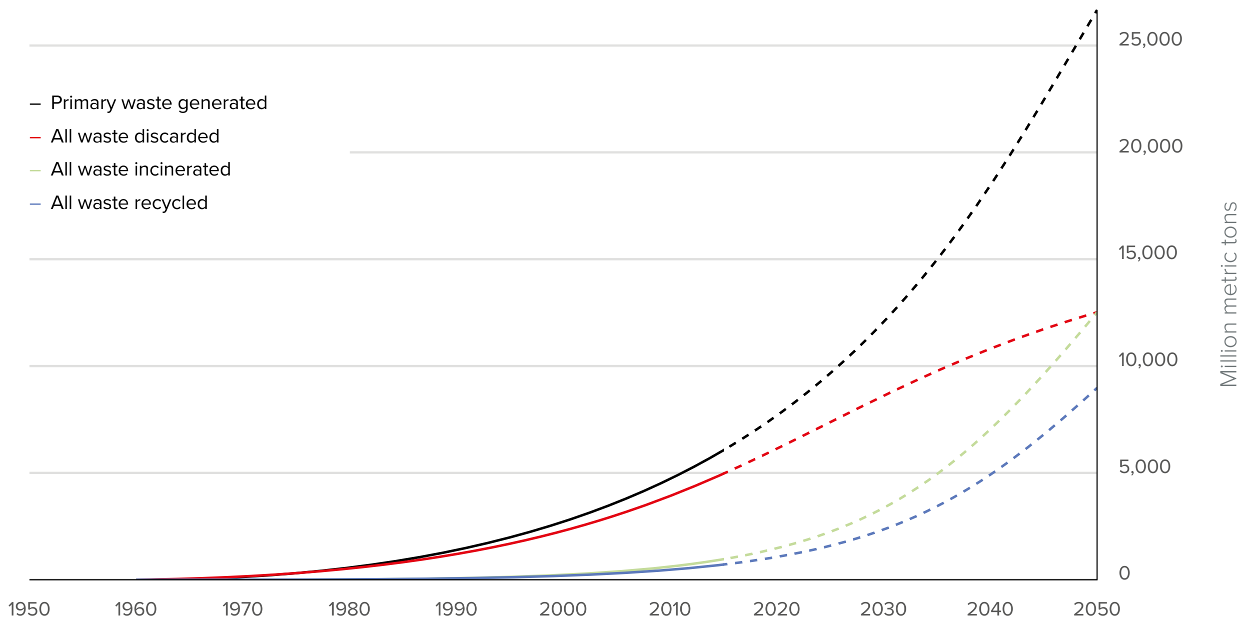
Plastic Waste Material Flow

The problem of plastic waste pollution started in the middle of the 20th century when commercial production of plastic products commenced as soon as plastic's desirable properties and potential benefits to society were established. From this point on, the applications of plastic materials have supported almost all modern aspects of our lives and propelled improvements in the general conditions and standard of living in many countries because they are affordable and have versatile uses.

The plastic economy became a major component of national economies and industrial development. Historical data indicates that the growth of national economies in various countries has been synonymous with growth in the demand and applications of plastic products domestically. Between 1950 and 2019, global production of plastic materials grew at a compounded annual rate of 8.2% to 460 million metric tons (Mt) (Geyer et al. 2017; OECD 2022). However, not all plastics produced each year become waste in the same year. This is because the lifetime of plastic products can vary from a single-use instance within a particular year up to a lifetime of around 60 years in building and construction applications (Geyer et al. 2017). Of the estimated 407 Mt and 460 Mt of plastics produced in 2015 and 2019, respectively, around 302 Mt and 363 Mt of new plastic waste was generated (Geyer et al. 2017; OECD 2022). As Figure 1 shows, global cumulative plastic waste generation is currently estimated to reach over 25 billion metric tons by 2050 (Geyer et al. 2017).

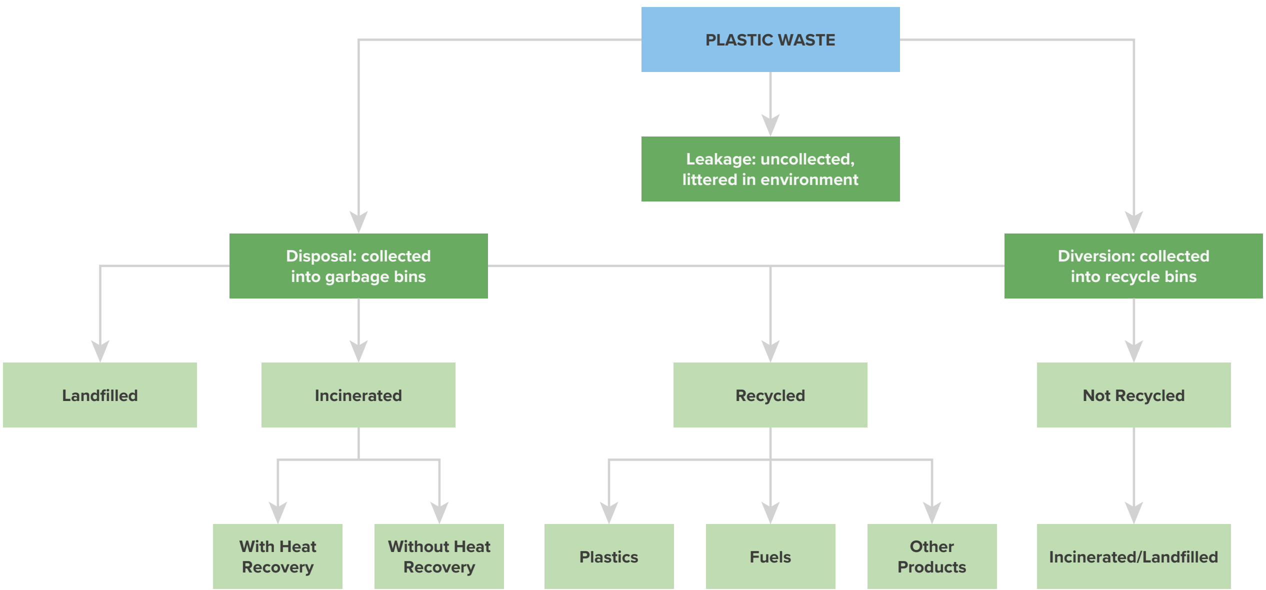
The challenge for a modern plastic material economy is ensuring that post-consumption waste does not end up in the environment as pollutants. As depicted in Figure 2, a review of current plastic waste material flow identifies three major pathways present both on land and in bodies of water. These include disposal in garbage cans, disposal in recycling bins, or leakage/littering (Umeozor et al. 2021).

Figure 1. Global cumulative plastic waste generation estimates from 1950 to 2050.



Source: Geyer et al. 2017.

Figure 2. Pathways of plastic waste material flows.

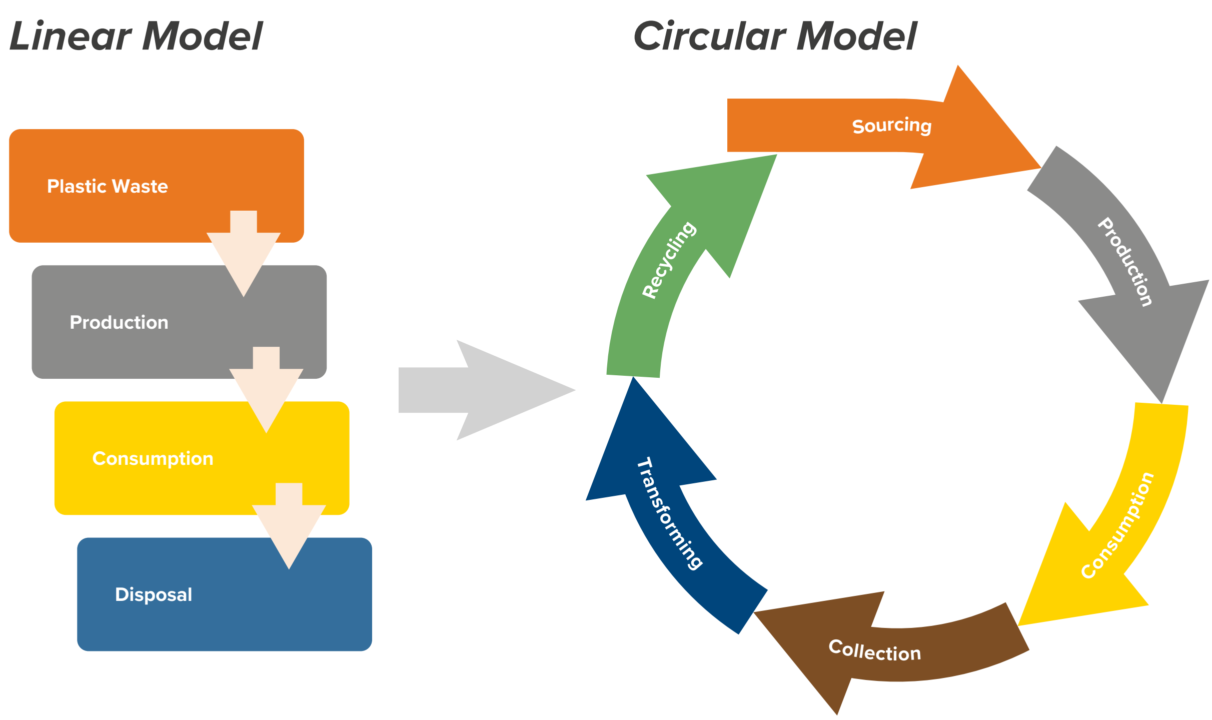


Source: Umeozor et al. 2021.

When waste plastics are disposed of in garbage cans, they can end up in landfills or be sent to incinerators, where they can be burned with or without energy recovery. Waste materials could also be retrieved and channeled toward the recycling stream. However, not all the properly channeled plastic waste in recycling bins can be economically recycled into new plastics using commercially available best practice technologies such as mechanical recycling. This is often due to the composition of the waste plastic, contamination, or degradation of the plastic material itself over time. For this reason, such hard-to-recycle components may still end up in landfills or repurposed for energy or other applications. Mismanaged plastic waste is responsible for polluting the natural world, including the marine environment. Advanced recycling technologies based on chemical conversion of hard-to-recycle plastic wastes into chemicals, materials, or fuels are being developed and deployed in many countries today.

Consequently, a circular economy model for plastics has been proposed by various experts as a solution to better plastic waste management, where post-consumption plastic materials are not treated as waste but as valuable resources in the economy (Umeozor et al. 2021, CCME 2018, TEMF 2013). As shown in Figure 3, the idea is to transition from a linear model of production, consumption, and disposal to one where waste is collected and transformed into various valuable end uses in recognition of the inherent value that modern waste products often embody. Considering that the issue of plastic pollution has been highlighted in public and general consciousness, leading to raised concerns among various national and international policymakers and stakeholders, a consensus on a global framework for circularity and the role of a circular economy model for plastics has yet to be reached.

Figure 3. Linear versus circular economy models for plastics.



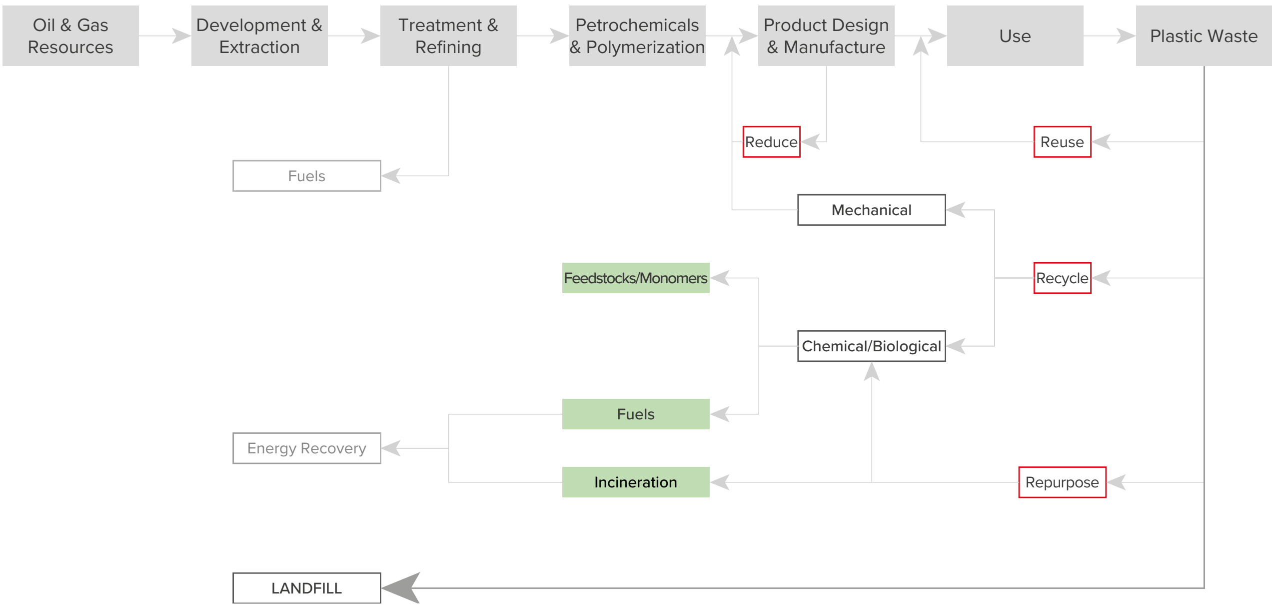
Source: Author.

Circular Economy Framework for Plastics

The circular economy framework has been applied to carbon dioxide emission mitigation based on four principles: reduce, reuse, recycle and remove (Luomi et al. 2021). Unlike plastic waste, which is solid, carbon dioxide is a gas and is generated from various energy-consuming processes.

The major environmental impact of carbon dioxide — global warming — results from its release into the atmosphere. Hence, the “remove” element is essential in cases where the first three principles are insufficient for eliminating the emission and its impending impacts. A framework based on reduce, reuse, recycle and repurpose seems more appropriate for plastic waste, because the fourth element, “repurpose,” is intended to address other value recovery options for when the first three elements are inadequate or inapplicable for managing waste (Umeozor et al. 2021; Ruto 2023). Some stakeholders have proposed “remanufacture” as an alternative element to repurpose, while others have proposed “repair” as an additional element. This paper proposes that “remanufacturing,” which is synonymous with mechanical recycling, should be covered under the recycling element, while “repair” should be under the “reuse” element. Figure 4 illustrates the proposed circularity framework in addition to the processes for end-of-life treatment under each element. Further descriptions of the plastic circular economy elements are provided in the following sections below. The preferred order for implementing the circularity elements is shown in Figure 5.

Figure 4. A circular economy framework for plastic waste pollution management.



Reduce

This entails reducing plastic pollution through better upstream design of products, simplification and providing adequate infrastructure to facilitate collection, diversion and efficient sorting. This is the lever for all stakeholders including policymakers, producers and consumers to create and adopt measures promoting the avoidance of leakages and plastic waste volume reduction. Waste reduction is also achieved by designing products for durability.

Reuse

Reusing post-consumption plastics also requires the design stage to enable multiple use cycles of a product. Product design must consider other potential uses that may not be the same as the one for which the original product design had been intended. Material strength and stability must be compatible for a longer lifetime to enable safe and extended reuse.

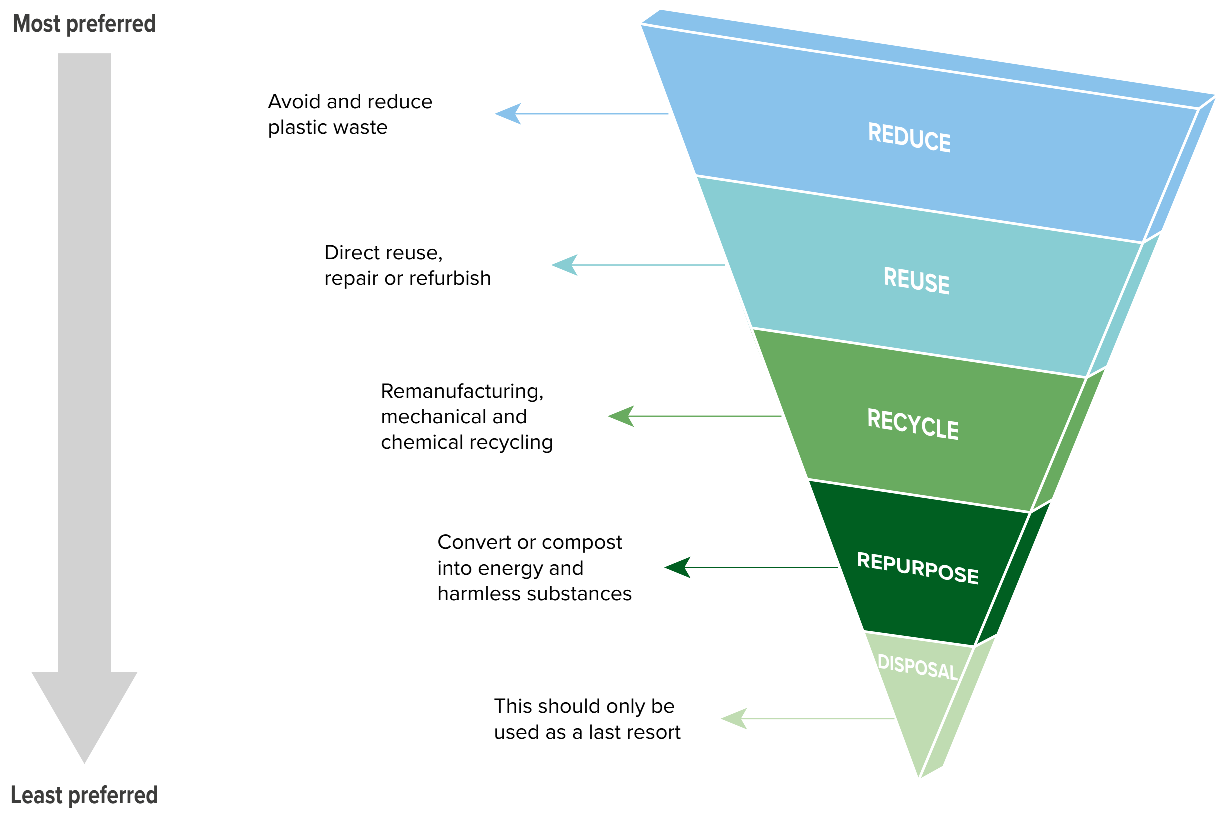
Recycle

Recycling post-use plastics should be open to all innovative technologies that can eliminate plastic waste from the environment and maintain a circular plastic economy model. Apart from mechanical recycling, which is the most common commercially deployed option, some other alternatives can address the limitations of mechanical recycling. These advanced recycling processes include pyrolysis, solvolysis, depolymerization, digestion and gasification. Advanced recycling techniques can leverage the attributes of plastic components, including additives or any contaminants, and result in the efficient recovery of components without releasing pollutants into the environment.

Repurpose

Repurposing plastic waste and its components can be applied in cases where the plastic materials can be returned to their fundamental building blocks or transformed for use in other sectors of the economy, such as construction or energy for power, transportation and heating services, without releasing any harmful chemicals into the environment. This solution has been deployed in many resource-deficient countries as a source of energy for mostly electric power and heating needs. For example, Japan and Sweden have very high plastic waste recovery rates and have created the ability to utilize most of their plastic waste for power generation.

Figure 5. Order of preference of circularity principles for life cycle management of plastic waste.



Source: Author.

In the order of priority, the preference in a circularity model should be to reduce, reuse, recycle or repurpose plastic waste and prevent leakage into the environment. Adopting a generalizable and consistent framework for the circular economy of plastics is crucial for enabling the common and effective implementation of control measures to be adopted through UNEP's ongoing INC meetings within a global treaty for plastic pollution management.

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