KAPSARC
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King Abdullah Petroleum Studies and Research Center

Plastics in the Circular Carbon Economy

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About KAPSARC

The King Abdullah Petroleum Studies and Research Center (KAPSARC) is a non-profit global institution dedicated to independent research into energy economics, policy, technology and the environment across all types of energy. KAPSARC's mandate is to advance the understanding of energy challenges and opportunities facing the world today and tomorrow, through unbiased, independent, and high-caliber research for the benefit of society. KAPSARC is located in Riyadh, Saudi Arabia.

This publication is also available in Arabic.

Legal Notice

Key Points

Plastics are a critical category in the chemicals value chain and have helped shape the modern economy. The COVID-19 pandemic has demonstrated the importance of plastics in people's lives. Throughout the international community, the demand for plastic has surged during the pandemic owing to the mass production of masks, personal protective equipment and gloves. Despite the importance of plastics, however, the world struggles to manage plastic waste and prevent its leakage into the natural environment.

Given this context, it is important to ask how the international community can promote circularity for plastics. To answer this question, KAPSARC launched a webinar series in 2021 that is convening thought leaders to address this topic. The first two sessions have provided the following insights:

- The Ellen McArthur Foundation found that virgin plastic production is growing at a rate of 5.4% a year. Additionally, 40% of plastic waste is from single-use items. Only 2% of plastics remain in the circular economy, and 98% of plastic production comes from new feedstocks.

- Preventing plastic leakage into the natural environment requires commitments from many stakeholders, including the private sector, government leaders, international organizations, research centers and consumers.

- Strategies to prevent plastic leakage should incorporate life cycle assessments and sustainability frameworks to help policymakers understand the strategies' economic, environmental and social implications.

Summary

KAPSARC hosted two webinars in the first half of 2021 to discuss policy options to promote circularity for plastics and reduce plastic waste in the environment. These events drew more than 240 participants from around the world, representing industry, the research community, international organizations and governments.

The webinar series is intended to challenge participants to consider plastics from various perspectives, including the economic, environmental, social, political, information and infrastructure domains. The speakers aim to challenge conventional wisdom and reinforce the need for a systems-level approach that includes life cycle assessments.

Background to the Workshop

It is essential to consider plastic's role from various perspectives, including the economic, environmental, social, political, information and infrastructure domains.

Economic Perspective

The production of new plastics and the trade in recycled components are parts of the interconnected global economy. The global trade in waste plastics was valued at $5 billion in 2007, and this valuation grew to $9 billion by 2017. Figure 1 illustrates the growth in this trade. The Center for Energy Studies and Rice University's Baker Institute for Public Policy highlight the interconnectedness of the trade in plastic waste, parings and plastic scrap.

Figure 1. Future of petrochemicals – external and internal factors.

Panel A. 1988.

Panel B. 2008.

Source: Rachel Meidl, Baker Institute for Public Policy.

Environmental Perspective

Advocacy groups, international organizations and the media have focused on the leakage of plastic waste into the natural environment. They have responded with regulatory changes, calls for bans on single-use plastics (SUPs) and discussions of extended producer liability. These groups have demanded the elimination of hard-to-recycle plastics from consumer goods. Although conversations about SUPs are important, questions of sustainability are also critical, especially as part of the energy transition. Many people do not realize that plastics play a critical role in reducing consumer goods' carbon footprint. Similarly, plastics are vital components of electric vehicles, wind turbines, solar panels and other technologies that play a role in decarbonizing the energy mix.

Social Perspective

Plastic is not only critical to the international economy but has also saved lives in the COVID-19 pandemic. It is a critical component of personal protective equipment (PPE), as hospital-grade gloves, medical suits, masks and COVID-19 test kits contain plastics. Plastic waste from personal hand sanitizer dispensers, disposable plastic gloves and disposable masks has increased during the pandemic. According to a conservative estimate, 129 billion face masks and 65 billion plastic gloves are used and disposed of each month (Aragaw and Mekonnen 2021). In addition to increasing the use of PPE, the pandemic has changed SUP consumption patterns in many ways. In exercising extreme caution, many communities have changed their rules regarding reusable bags and refillable water bottles. They shut off water fountains to avoid spreading the coronavirus. With many restaurants closed, SUP consumption and the use of plastic packaging have increased. Although plastic products have provided protection during the pandemic, it is necessary to develop strategies to manage waste and improve opportunities to create circularity.

Political Perspective

The leakage of plastic waste into the natural environment has created international political tensions. Although the United States (U.S.) manages domestic waste effectively, it exports scrap plastic to other countries for recycling or disposal. Until 2018, the U.S. exported a large percentage of its waste to China for recycling. When China banned the importation of waste plastic, other countries began importing it for recycling. However, these countries faced challenges owing to inadequate or absent waste management infrastructure. Political strains between consumer countries and countries that accept plastics for recycling emerged. There have also been some high-profile refusals of shipments and demands to return waste to its sender.

Information Perspective

Many stakeholders are calling for studies to understand the baseline conditions of plastic leakage. Research into laife cycle assessments (LCAs) is also needed to understand plastic's costs and benefits. Policymakers need reliable LCAs to make decisions that acknowledge the tension between sustainability goals and circularity objectives. Presenters in the webinar highlighted the need for education programs to help consumers understand ways to reduce harmful consumption patterns. Better community-level information on proper plastic recycling is also needed.

Infrastructure Perspective

International regulations relating to the plastic waste trade are changing. Investments in new chemical recycling technologies, combined with enhanced plastic waste collection, can help reduce waste leakage. Investments in waste management and recycling technologies at the point of consumption need to be considered as well. Shifting the burden to the least developed countries for processing is unlikely to be sustainable in the long run. Support for developing waste management infrastructure in these countries is needed.

Findings

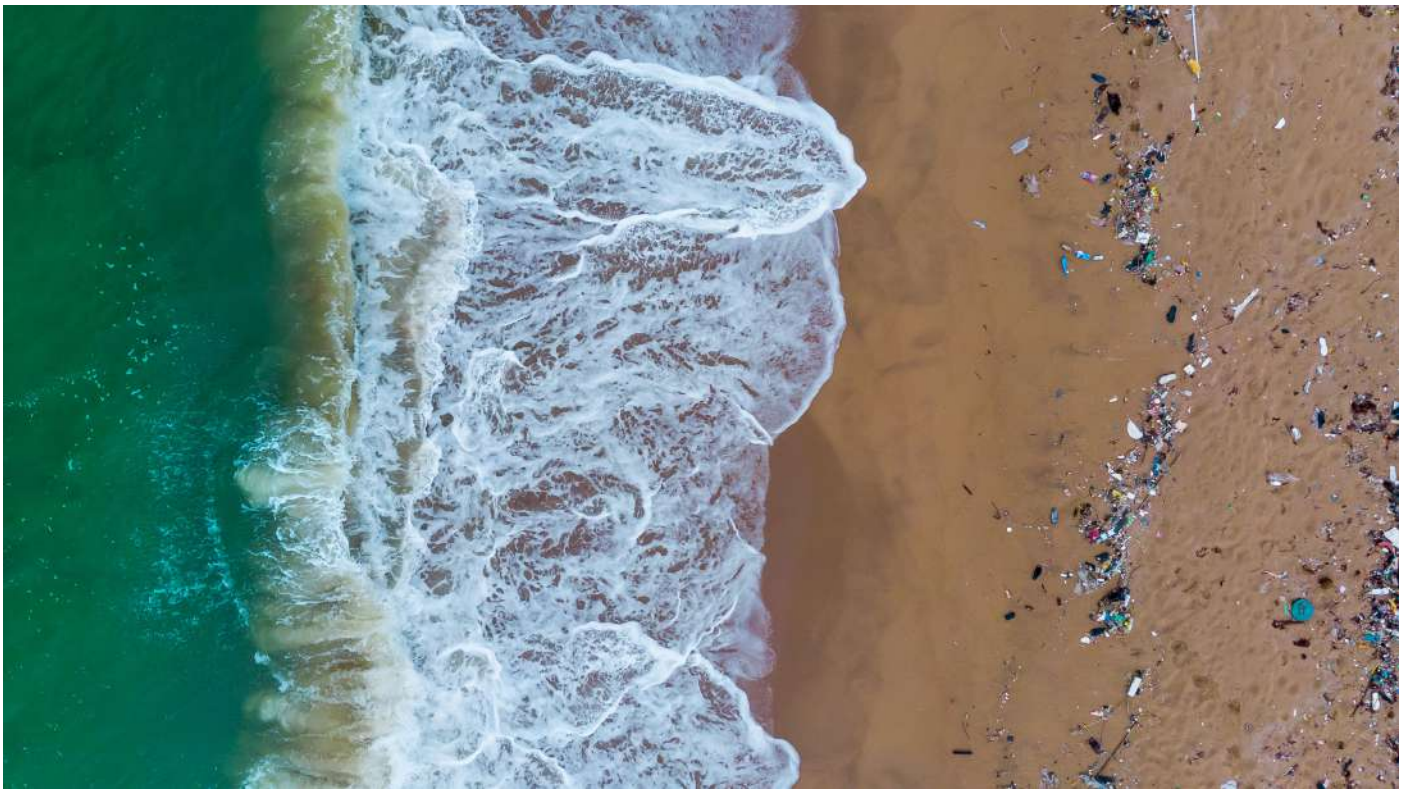
International Perspectives

International organizations such as the United Nations (U.N.) play a key role in raising awareness about plastic waste leakage. Plastic pollution was therefore set as a priority during the 73rd Session of the U.N. General Assembly, with a call to member states to change their approaches from design to consumption patterns and recycling. Similarly, the G20, a group of leading rich and developing nations, has recognized the challenges associated with plastic pollution. The group has called for member states to address marine plastic litter and microplastics. Osaka Blue Ocean Vision was adopted under the auspices of Japan's G20 presidency in 2019. The project addresses the need for coordinated efforts to reduce the environmental harm caused by plastic waste. It calls for a comprehensive life cycle management approach to be implemented by 2050. In November 2020, at the G20 Summit hosted by the Kingdom of Saudi Arabia, the Leaders Declaration reinforced the G20's role. This declaration reaffirmed the commitment to Osaka Blue Ocean Vision.

Within the U.N. Development Program (UNDP), the U.N. Sustainable Development Goals address plastics within a waste management context. The UNDP contends that waste management is a strategic challenge. The program draws attention not only to overarching waste management challenges but also to changing consumption patterns. Until the middle of the twentieth century, people tended to use goods until they were broken, worn out or no longer useful. After World War II, plastics were incorporated in consumer goods during an era of shifting mindsets toward consumerism and convenience. With economic growth, increased disposable income and shifting gender roles, many people adopted a linear approach described as 'take, make and dispose'. Today, many policymakers and consumers are pushing back on that approach. Instead, they promote a circular economy, emphasizing the construct of 'reduce, reuse, recycle and re-enter'.

In Saudi Arabia, Vison 2030 speaks to quality of life issues, and the control of plastic waste is embedded in this strategic goal. Meanwhile, poor plastic waste management may impact economic development, especially in the country's new tourism industry. Academics highlight the challenges that countries with established tourism industries face in managing SUPs. Beachgoers tend to leave plastic refuse behind and the leakage of plastic waste from countries with inadequate waste management infrastructure ends up along the coastal communities that rely on tourism and fishing for economic livelihoods.

Figure 2. Tourists expect pristine beaches and well-kept historical sites, but waste management is needed to reduce plastic leakage across the entire chain.



Source: KAPSARC.

International Regulatory Changes: Basel Convention, Regional and Domestic Changes

In addition to discussing international development perspectives, the webinar sought to provide insights on new regulations regarding waste plastic trade. During the 1980s, many wealthy countries shipped hazardous and household waste to poorer countries without prior consent. Thus, they created environmental harm in communities with inadequate waste management systems. The international community sought to end this sort of dumping through the Basel Convention. The Basel Convention was one of the first international environmental agreements, having entered into force in 1992. Saudi Arabia is a party to the Basel Convention, as are 186 other countries. This international agreement provides oversight of international trade and influences domestic approaches to waste management. It focuses on regulating international trade in waste intended for disposal, recovery and recycling.

This international agreement recently became relevant to the issue of plastics. Before 2021, plastic waste was outside of the scope of the Basel Convention and was only subject to national import rules. Since plastic was categorized as non-hazardous waste, it did not trigger regulation under the Convention. However, the plastic waste leakage problem inspired Norway to propose an amendment to the Basel Convention in 2018. Less than one year later, parties to the Convention adopted a more rigorous approach to the plastic waste trade. The new rules came into force in January 2021.

At a high level, these new regulations require prior informed consent for trade in most scrap plastics. Limited exceptions are made for some pre-sorted, cleaned and separated polymers that are easily recycled. The requirement of prior informed consent directly impacts international shipments of most plastic scrap and waste destined for recycling and disposal. Although the new regulations are intended to reduce plastic waste leakage, they may reduce circularity in some ways by creating procedural delays. Prior informed consent by governments helps to prevent dumping, but it also slows down international trade. The cost of recycled plastics may therefore increase because of the stricter regulations.

A complicating factor is that the U.S. is not a party to the Basel Convention. This status creates an obstacle for trade between Basel Convention parties and the U.S., reducing efficiency. Optimally, trade barriers should be reduced to enable a greater flow of waste plastic to advanced recycling facilities.

The amendment to the Basel Convention signals that additional international regulations may be forthcoming. Although the Basel Convention focuses on the waste plastic trade, it does not consider waste leakage comprehensively. For example, environmentalists see a need to improve labeling, reduce SUPs and mandate a higher percentage of recycled content in consumer products. None of these policy proposals is covered in the Basel Convention.

A new international convention will likely be established under the auspices of the U.N. Environment Assembly (UNEA), which has focused on this topic since 2017. The UNEA started setting goals to reduce the discharge of microplastics and detriment to marine environments with UNEA 3. In 2019, it also set resolutions on marine litter and SUPs. Legal experts expect countries to adopt mandates to negotiate for a new international

convention on plastics at UNEA 5 in February 2022. The scope of this convention remains to be determined. However, it may address the entire life cycle of plastics, including design mandates and command and control over plastic waste management. This treaty will likely dominate global plastic-related attention for two to three years beginning in mid-2022.

European Perspectives

In addition to international efforts, many regional efforts are promoting circularity for plastics. The trade organization Plastics Europe represents the plastics industry and works with more than 100 member companies. These companies produce 90% of polymers across the European Union. This organization reinforces the societal benefits of plastics and works with diverse stakeholders to reduce harmful environmental and health impacts.

From Plastics Europe's perspective, the problems with leakage are well known, and a large percentage of leakage comes from consumer food packaging and SUPs. Plastics Europe highlights the urgency of leakage. It takes the perspective that global action is needed and a binding U.N. agreement to end plastics pollution is required. Most countries and stakeholders, including chemicals and plastic resin producers, support the creation of an International Negotiating Committee for a global plastics agreement at UNEA 5. Without concerted change, plastic waste leakage will worsen. The annual flow of waste is projected to triple by 2040.

Plastics Europe supports the implementation of policies under the European Green Deal. These policies provide a blueprint for sustainability regarding plastics and other environmental issues. The European Commission has set several objectives for plastics, including making all plastic packaging reusable by 2030 and increasing the demand for recycled plastic fourfold. It aims to remove substances that hamper the recycling process and increase innovative materials in the production of plastics. Europe is also committed to creating better recycling technologies and equipment. This strategy links economic development and job creation to circularity. It expects to add more than 200,000 jobs in the recycling industry by 2030.

Solution Toolkit

The webinar series aims not only to frame the discussion on plastics in a circular economy but also to create a solution toolkit.

Some of the webinar content helped to define the challenges and approaches in the international community. However, speakers from policy organizations and industry also focused on solutions for reducing plastic leakage. LCAs, chemical recycling and waste management investments were some of the options discussed.

LCAs

Rice University's Baker Institute for Public Policy reinforced the need to use sustainability frameworks and introduced LCAs. Often, consumers and policymakers are swayed by compelling visuals illustrating the problems with plastic but do not consider the benefits at the system level. Options that seem to be more eco-friendly may have more significant carbon footprints than plastic products have. Plastics are low in weight and cost-effective and have smaller impacts on greenhouse gas (GHG) emissions than alternative options do. For example, aluminum cans and glass bottles emit 2.5 times and 4.3 times as much GHG, respectively, as plastics do.

Rigorous LCAs carefully analyze other aspects of a product besides the fact that it is single-use. They create a full picture of a product's carbon impact. Effective LCAs evaluate a process from the acquisition of raw materials through manufacturing to the consumption and final disposal of a product. When framed properly, LCAs can help stakeholders gain insights into the opportunities to optimize a process to keep plastics in the economy and limit harm.

An often overlooked issue is that promoting a circular economy sometimes runs counter to sustainability goals. Systems-level thinking considers plastic from economic, social and environmental perspectives. Thus, it captures the complexity of plastics and can help inform policymakers and consumers about their costs and benefits. LCAs can help policymakers understand the complexity of a topic, thereby reducing the unintended harmful consequences of decisions based on emotions rather than analyses.

Many corporate entities have conducted LCAs to determine the most sustainable options for consumer goods. Whereas conventional wisdom suggests that glass or aluminum containers are the best choices for the environment, LCAs may indicate otherwise. For example, the makers of the popular beverage Snapple shifted from glass bottles to 100% recycled plastic, as shown in Figure 3. LCAs showed that shifting to recycled plastic would save energy, promote circularity and create a demand signal for recycled components within the industry. Not all consumers were happy with the shift. Thus, the company launched a public education campaign explaining that lightweight plastic bottles are 10 times lighter. The lighter weights create efficiencies in shipping, thus reducing carbon emissions from trucks.

Figure 3.LCAs influenced Snapple's shift from glass to plastic.

Source: KAPSARC.

In addition to their role in consumables, plastics are a key component of durable goods. In the context of larger sustainability discussions, the use of plastics involves tradeoffs. For example, policymakers have set targets for the creation of zero-emission vehicles by 2030, which will increase the demand for plastics. Similarly, 100% carbon-free electricity production may increase the demand for complex multimaterial components that are produced using plastics. LCAs may deliver solutions that involve landfilling rather than recycling plastic waste when costs are high or no market for recycled plastics exists.

Industry Perspectives

Similar to the need for greater emphasis on LCAs, industry officials call for greater optimization in each part of the value chain to prevent leakage. At present, analyses generally focus on one stage, such as the role of consumers in recycling, rather than on each segment of the circular economy. With these narrow focuses and emphasis on consumers, it is difficult to identify opportunities to optimize the whole system.

Aligning incentives is also challenging because it requires cooperation at the domestic, regional and international levels and collaborations among stakeholders across domains. In part, the problem is complex because stakeholders have different desired end states for plastics. The value chain is complex and creating circularity requires the coordination of processes and priorities from the petrochemical industry, through to industry leads and retailers, down to consumers, waste collectors and recyclers.

Solving the problem of plastic leakage and promoting circularity will require technology and policy choices on many fronts. The webinar described initiatives by Oxford Sustainable Fuels, Saudi Basic Industries Corporation (SABIC) and the Saudi Investment Recycling Company (SIRC). These discussions provided insights on initiatives in the Kingdom and internationally.

Oxford Sustainable Fuels provided insights into research on pyrolysis. This method is one option for reducing the amount of plastics discharged into the

ocean, incinerated or landfilled. Industry and policy centers alike view the technology as promising. They believe that 60% of plastic production may use this process by 2050. All recycled plastic will ultimately reach the end of its useful life. Polymers break down during the recycling process, and it is impossible to keep reproducing the same product quality. When a product reaches the end of its life, it is possible to recycle the chemicals that it contains. These components are turned back into polymers and either stay in the circular economy or return in waste-to-fuel or waste-to-energy applications. Although this technology is promising, some major obstacles to cost-competitiveness with new plastics remain. Most notably, inefficiencies in waste management keep waste plastic in the value chain and out of the natural environment.

SABIC provides amplifying analyses from a manufacturing perspective. SABIC is one of the world's largest petrochemical producers and has served as a leader in creating the TrueCircle campaign. SABIC has created certified circular products using pyrolysis oil and certified renewable products that use renewable products' feedstocks to develop new products. In addition to developing mechanical and chemical recycling processes, SABIC focuses on improving the design of packaging. Its ultimate goal is to increase recyclability and engage with consumers to develop opportunities to recycle plastics that were not previously recycled. SABIC's partnership with Tesco in working with consumers in European markets to recycle plastic components that were not previously recycled has been successful.

The Saudi Arabian Public Investment Fund identified recycling as a critical area for attention. Thus, it launched the SIRC in 2017. The company supports Vision 2030's environmental and sustainability goals and leads domestic efforts to create circularity for waste, focusing on mechanical and chemical recycling. Webinar speakers profiled industry innovations for achieving this goal. SIRC is working toward an ambitious mandate. It aims to divert 100% of municipal solid waste, 60% of construction and demolition waste and 85% of industrial hazardous waste from landfills by 2035. SIRC's mission is nested within the larger Saudi Green Initiative and Middle East Green Initiative, which address environmental stewardship and circularity.

SIRC's approach focuses on mechanical and chemical recycling, and it has conducted sector readiness assessments for distinct waste streams in Saudi Arabia. Domestic investment in chemical recycling is already underway in Europe. European plastics manufacturers plan to increase investment in chemical recycling from 2.6 billion euros in 2025 to 7.2 billion euros in 2030. SIRC has undertaken a waste management study in Saudi Arabia to understand the existing waste management process and improve the system. Although public collection services are smooth, other phases can be improved. Notably, changing consumer behavior, improving bin infrastructure and optimizing treatment and recycling steps are all areas for improvement.

Domestic policy changes are on the horizon in Saudi Arabia, and these changes will help SIRC in its mission. For example, Saudi Arabia will require sorting at the source starting in 2021, with compliance by 2023. National regulations on the minimum recycled content for plastics are slated to come into effect by 2023. Taxes on new construction have also been proposed to make recycled materials cost-competitive. Waste management investments in the Kingdom are essential to meet the environmental goals of Vision 2030. These investments are also seen as an opportunity for job creation and economic growth; SIRC's initiatives are projected to provide benefits worth 37 billion riyals.

Conclusion

In the modern era, plastics touch many different parts of people's lives. Strategies to address issues with plastics must incorporate political, economic, social, infrastructure and information perspectives, among others. The international community has acknowledged the critical role of plastics in the global economy. Simultaneously, it recognizes that plastics pose a problem of permanence because they do not decompose in the natural environment but rather break down into microplastics. The first two webinars sought to introduce this issue from diverse perspectives. The team looks forward to additional opportunities to continue the dialogue on this topic. The aim is to contribute to the solution sets and influence policy toolkits that balance sustainability, circularity and environmental justice.

About the Workshop

This workshop took place as a series of webinars in Riyadh on March 24, 2021, and June 30, 2021. Both sessions brought together governmental and non-governmental stakeholders to discuss key issues related to plastics in the circular economy.

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About the Team

Sara Lechtenberg-Kasten

Sara Lechtenberg-Kasten is a research fellow in KAPSARC's Transport and Urban Infrastructure program. She joined KAPSARC in 2015, bringing extensive experience in designing politically sensitive studies for governmental and non-governmental organizations. Sara has worked at the strategic, operational and tactical levels to design and manage studies on organizational change. She has also led multidisciplinary teams and worked with clients worldwide. She has experience working in Saudi Arabia, Haiti, El Salvador, Kuwait, Nigeria, Thailand and South Africa.

Jitendra Roychoudhury

Jitendra is a fellow in the Transportation and Infrastructure program. His ongoing research portfolio at KAPSARC covers various issues related to economics, energy and freight, transport policy developments, and the impact of such policies on global energy markets. He is currently working on the nascent hydrogen industry, researching the impact of hydrogen, green ammonia and other low carbon fuels on freight, maritime, aviation, industry and geopolitics. Before joining KAPSARC, Jitendra was director and chief consultant at HDR Salva, India. He has worked extensively as a commodity consultant within India's energy and infrastructure sectors, advising on developing commodity market entry strategies. He has authored and contributed to numerous consulting studies related to coal and coal policy in India, Indonesia and China. Jitendra has a bachelor's degree in mechanical engineering from the University of Pune, India, and a postgraduate diploma in business management from Welingkar's Institute of Management, Mumbai.

Aisha Al Sarihi (Former Research Associate)

Aisha's research interests focus on the environment, energy policy and climate economics and policies. She obtained her Ph.D. at Imperial College's Centre for Environmental Policy. Her thesis focused on policies and challenges for renewable energy adoption in oil-producing countries. Following her Ph.D., Aisha pursued her postdoctoral research at the London School of Economics and Political Science's Middle East Centre, working on assessing the economic implications of climate change in the GCC. She also joined the Arab Gulf States Institute in Washington, studying the challenges and opportunities for aligning climate policies with economic diversification strategies in Saudi Arabia, Oman and the UAE. Before joining KAPSARC, Aisha worked at Georgetown University's Center for Contemporary Arab Studies as a visiting scholar.

About the Project

Plastics are a critical category in the chemicals value chain and have helped shape our modern economy. KAPSARC launched the Plastics in a Circular Economy project in 2021 to identify obstacles and opportunities to promote circularity and prevent leakage of plastic into the environment. The KAPSARC team works with stakeholders from around the globe to focus on innovations and technologies to move from the linear approach to waste management to more sustainable options for plastics.

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