CIRCULAR PLASTICS SUPPLY CHAIN

INDUSTRY OVERVIEW SEGMENTS

ENERGY & MANUFACTURING in Appalachia

INDUSTRY OVERVIEW SEGMENT – CIRCULAR PLASTICS

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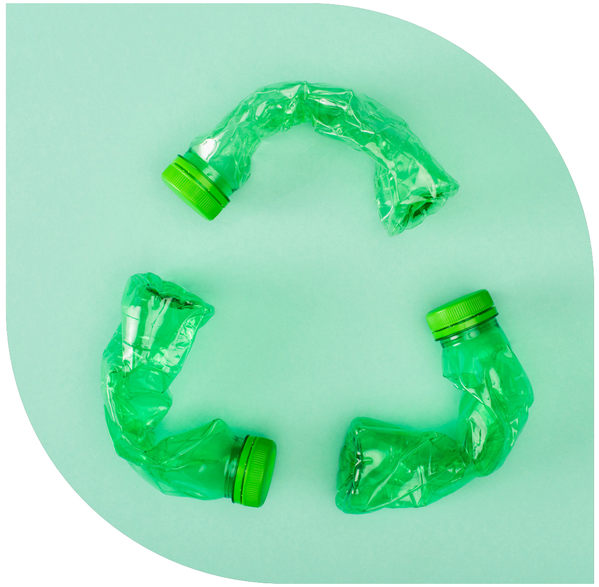
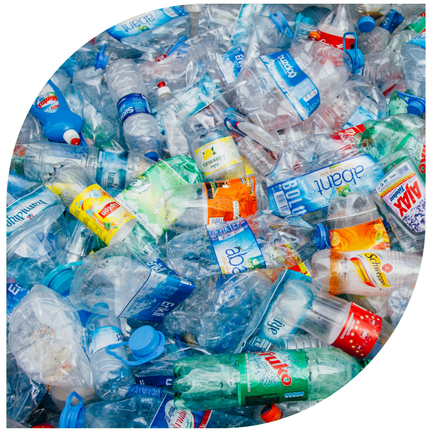
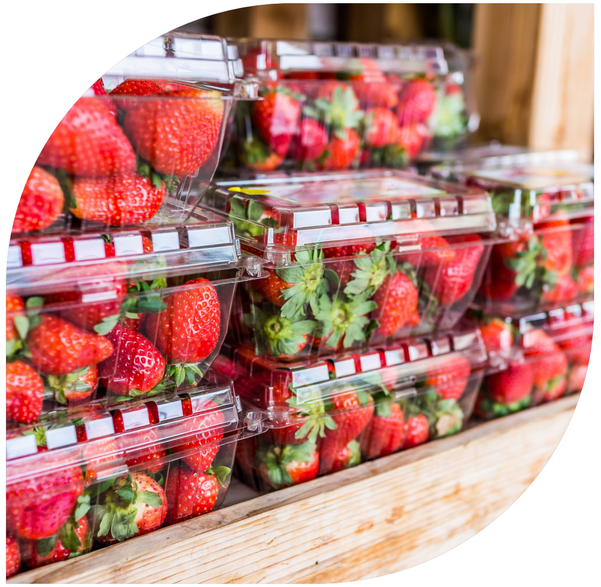
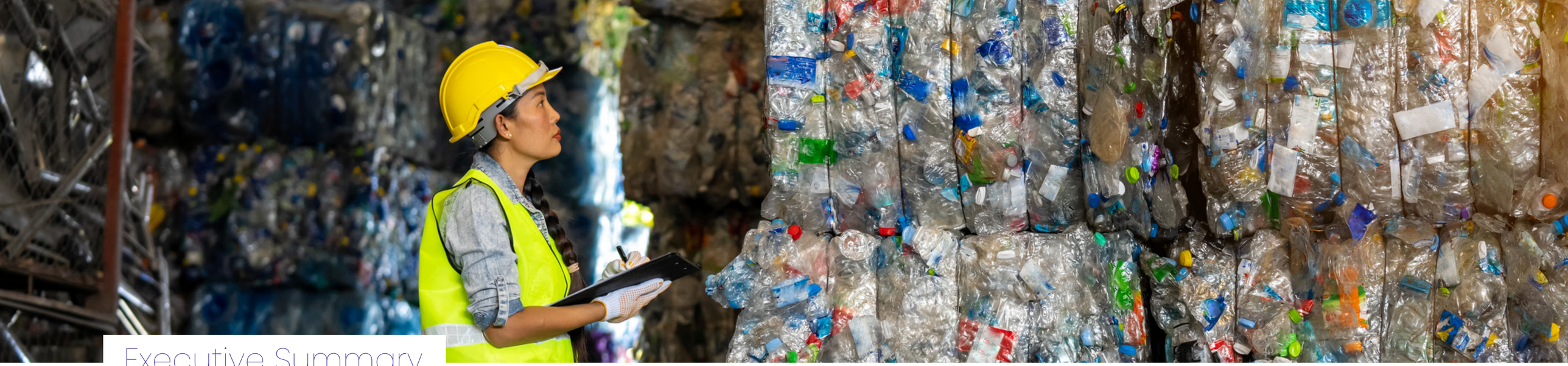








Executive Summary

Currently, the U.S. circular plastics industry faces conflicting landscapes. On one side, the current federal administration is cutting regulations and funding that were driving a move to more sustainable technologies. On the other hand, state governments and global markets are aggressively demanding recycled materials. This creates a complex but opportunity-rich landscape for manufacturers who can navigate the divide and capture market share.

The transition from a linear "make-and-dispose" economy to a circular “extracting maximum resource value” model is driving significant capital movement.

While federal EPA funding is largely frozen, the market fundamentals for circular plastics remain strong. The global circular plastics market is projected to reach $182 billion by 2034, driven by corporate commitments, international markets and state-level mandates. In the U.S., the advanced recycling sector (chemically recycling plastics) is forecasted to grow from **$8.9 billion in 2025 to $14.4 billion by 2030**.[1]

This roadmap identifies opportunities for manufacturers to capture market share in a growing, circular plastics supply chain.

Key Drivers: State-specific Extended Producer Responsibility (EPR) legislation, corporate ESG commitments (e.g., recycled content mandates), and volatility in virgin resin prices. [2]

Additionally, international market policies, such as Europe’s recycled plastic content requirements, are driving US plastics manufacturers to invest heavily in recycled content feedstocks.

The Circular Plastics Supply Chain Map

This roadmap illustrates the stages of the circular economy for plastics, including opportunities for manufacturers to capture market share in the ever-growing supply chain. We'll also explore the policies and regulations that are driving significant capital investment in circular plastics.

COLLECTION, AGGREGATION, SORTING AND PRE-PROCESSING

Feedstock Preparation and Generation

Before plastics can be circular, they must be recovered. This sector is moving beyond simple trash collection to sophisticated "resource recovery."

Post-consumer (PCR) and post-industrial (PIR) waste is collected via curbside programs, deposit return programs(DRS), and industrial take-back programs.

Collected waste is separated from other materials at sorting and recovery centers, where advanced sorting technologies are used to identify and isolate specific plastics for processing.

Waste collected for advanced recycling is often shredded, ground, or densified at specialized facilities before being chemically treated.

Key technologies for advanced recycling waste collection include AI-powered sorting and robotics for accurate separation, smart waste management systems with sensors and data analytics for efficient collection, and advanced communication and tracking systems like blockchain for supply chain transparency.

Relevant NAICS Codes:

- **562111:** Solid Waste Collection (General curbside).
- **562920:** Materials Recovery Facilities
- **562119:** Other Waste Collection:
- **423930:** Recyclable Material Merchant Wholesalers (Brokers selling baled waste).
- **334511:** Sensors Manufacturing: Navigation, GPS & Detention Systems
- **334513:** Sensors Manufacturing: Industrial Process Sensors
- **334413:** Semiconductor and Related Device Manufacturing
- **541512:** Integrating Hardware & Software Systems

CIRCULAR PLASTICS FEEDSTOCK CONVERSION

In this phase, the supply chain splits into two distinct paths based on the quality of the feedstock.

There are well-established markets for mechanically recycled plastic feedstocks composed primarily of plastics labeled as "1" and "2". These plastics include PET (Polyethylene Terephthalate), which includes water and soda bottles, and HDPE (High-Density Polyethylene), which includes milk and water jugs.

Emerging markets for plastics labeled as "4" (low-density polyethylene), "5" (polypropylene) and "6" (polystyrene) in the advanced recycling feedstock markets is growing as new technologies emerge to transform these end-of-life plastics into various circular feedstocks. These plastics encompass packaging and products such as grocery and produce bags, yogurt and sour cream cups, and styrofoam products.

The Circular Plastics Supply Chain Map

Path A: Mechanical Recycling (Physical Conversion)

Mechanical recycling is well-established and best deployed to repurpose clean, mono-material streams, primarily PET and HDPE end-of-life plastics.

The process is generally to wash, to grind, to extrude plastics and pelletize them for reuse. The output is typically PCR pellets (post-consumer resin) that retain the polymer's original structure. There are some challenges related to the degradation of the materials, the more they are recycled and challenges with odors. However, deodorization technologies to remove smells from recycled detergent and food containers using "super-cleaning" processes for food-contact approval are advancing. [3]

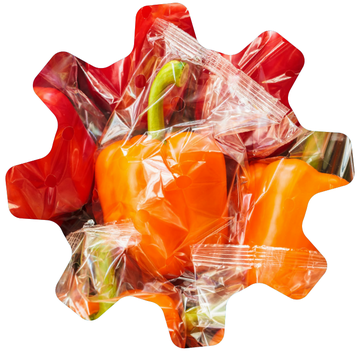
Path B: Advanced / Chemical Recycling (Molecular Conversion)

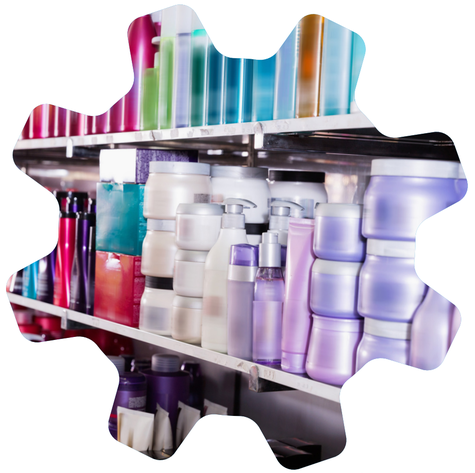
Advanced plastics recycling is a broad category that encompasses several different processes to convert post-use plastics into their original base feedstock materials that can be used to manufacture new plastics, chemicals and other value-chain products.

This method is designed to recycle complex, mixed, or contaminated plastics (films, multi-layer pouches) that mechanical recycling cannot handle.

Advanced recycling can be defined as **chemical or molecular recycling**, which utilizes thermochemical processes (such as pyrolysis or gasification) to transform plastic waste.

Unlike mechanical recycling, which simply preserves the plastic's physical structure, advanced technologies break the covalent bonds of complex polymer chains. This converts post-use plastics back into its fundamental molecular building blocks—yielding liquid or gaseous feedstocks comparable to fossil fuels. These purified monomers can then be re-polymerized into virgin-quality plastic, enabling a truly circular economy where materials are endlessly regenerated without performance degradation.





Key Technologies:

- **Pyrolysis:** Heating plastic in the absence of oxygen to produce "pyrolysis oil" (a naphtha substitute). [4]
  - **325199:** Other Basic Organic Chemical Mfg
  - **333249:** Other Industrial Machinery Manufacturing (vats, bioreactors and chemical production equipment)
  - **562213:** Solid Waste Combustors
- **Gasification:** Converting plastic into synthesis gas (syngas) for chemical production.
  - **325199:** Other Basic Organic Chemical Mfg
  - **325120:** Industrial Gas Manufacturing (specific to industrial gas production)
  - **333249:** Other Industrial Machinery Manufacturing (vats, bioreactors and chemical production equipment)
- **Enzymatic Recycling:** Using biological enzymes to depolymerize PET at low temperatures (e.g., Carbios technology). [5]
  - **333249:** Other Industrial Machinery Manufacturing (vats, bioreactors and chemical production equipment)
  - **325199:** Other Basic Organic Chemical Mfg (Industrial enzyme production)

The Circular Plastics Supply Chain Map

PURIFICATION & POLYMERIZATION

The materials that are produced from the advanced recycling technology process often require additional steps to purify and/or re-polymerize the outputs for manufacturing and end-product application. The most common practice takes the pyrolysis oil and processes it using existing, high-capacity petrochemical crackers, thereby leveraging existing multi-billion dollar assets to produce new feedstock materials, which include recycled content.

Through purification and re-polymerization, the chemically recycled feedstocks are linked back together in long chains (polymers) to create the plastic resin. This is the exact same process used to create virgin plastic, only the output now contains recycled materials.

The final product is a virgin-quality plastic resin pellet (e.g., Circular Polyethylene), often certified through a Mass Balance protocol (like ISCC PLUS) to track the recycled content.

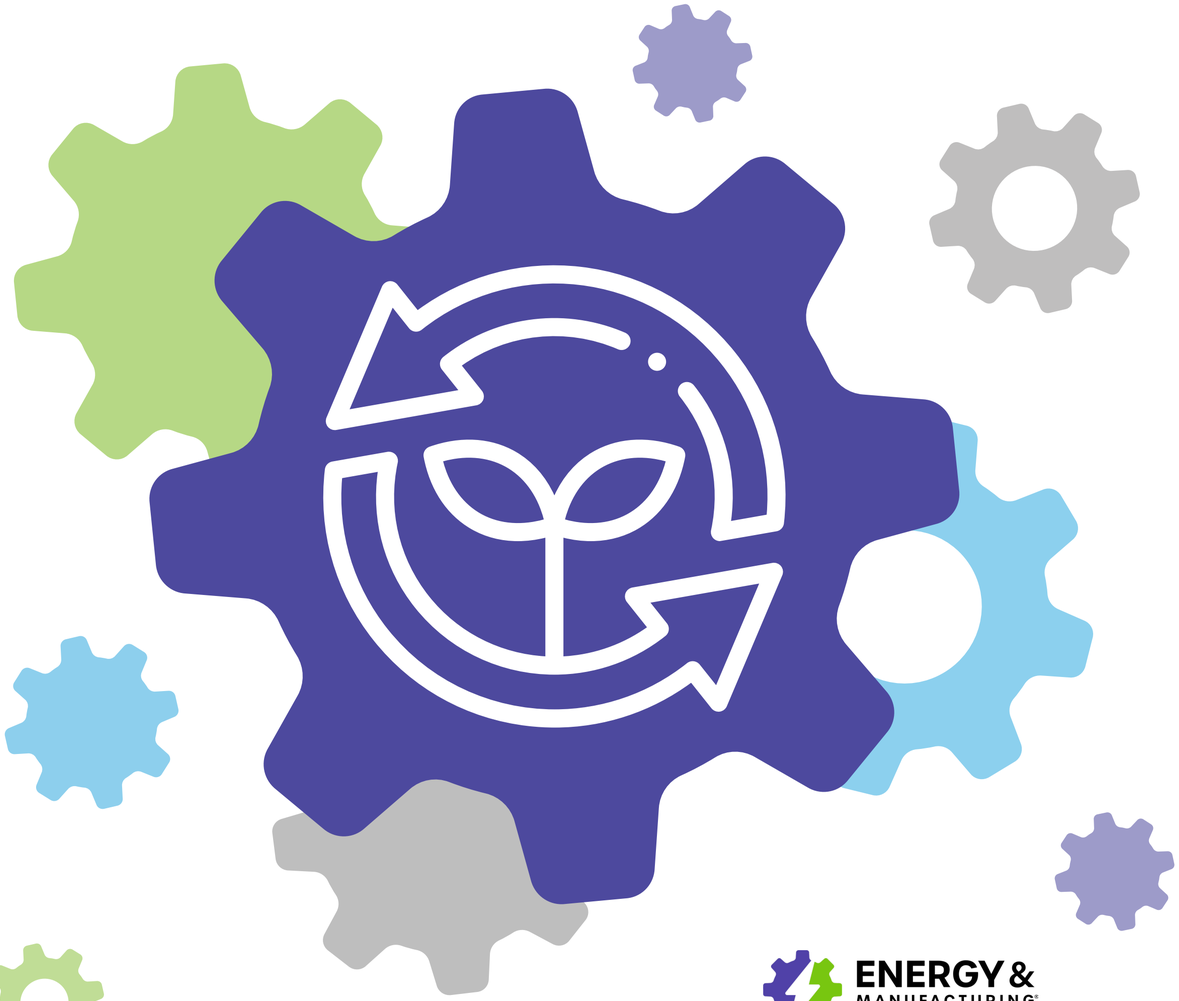
The Opportunity

Trade industry groups such as the American Chemistry Council (ACC) strongly advocate for the use of the Mass Balance chain-of-custody methodology. Mass Balance is a crucial accounting tool needed to accurately track and scale the use of recycled content, particularly from advanced recycling (chemical recycling), within existing global chemical infrastructure. [9]

Utilizing a chain-of-custody methodology allows manufacturers to claim "mass balance" recycled content for high-performance applications (medical, food contact) using ISCC PLUS certification. [6]

Relevant NAICS Codes:

- **324199:** All Other Petroleum and Coal Products Manufacturing
- **325110:** Petrochemical Manufacturing.
- **325211:** Plastics Material and Resin Manufacturing.



The Circular Plastics Supply Chain Map

MANUFACTURING (END-PRODUCT APPLICATION)

Chemically recycled feedstocks create a true closed-loop system for plastics, enabling infinite recycling without sacrificing the performance or safety required by the most demanding manufacturers and applications.

Because the output plastic resin is chemically identical to its virgin counterpart, it can be used in all applications, including those with strict regulatory requirements where traditional mechanical recycling is often prohibited.

Here are examples of how chemically recycled plastic is used in manufacturing.

APPLICATION TYPE	HOW CHEMICALLY RECYCLED PLASTIC IS USED	EXAMPLE PRODUCTS
Food Contact	Requires guaranteed purity and freedom from residual contaminants, which only monomer-level purification can achieve.	Yogurt cups, fresh produce packaging, plastic bottles
Medical/ Pharmaceutical	Needs materials with guaranteed mechanical integrity and no leaching of impurities.	Drug packaging, medical device housings, specialized films.
High-Performance	Demands specific, consistent performance that cannot tolerate the degradation (shorter polymer chains) common in mechanical recycling.	Automotive parts (interior and exterior), high-stress films, complex multi-layer packaging.
Cosmetics & Personal Care	Requires optical clarity and brand consistency that colored, blended mechanical resins cannot provide.	Shampoo bottles, cosmetic containers, opaque packaging.

Relevant NAICS Codes:

- **3261:** Plastics Product Manufacturing. [7]
  - **326160:** Plastics Bottle Manufacturing
  - **326111:** Plastics Bag and Pouch Manufacturing
  - **326122:** Plastics Pipe and Pipe Fitting Manufacturing
  - **326140:** Polystyrene Foam Product Manufacturing
  - **326199:** All Other Plastics Product Manufacturing
- **325211:** Plastics Material and Resin Manufacturing
- **325991:** Custom Compounding of Purchased Resins

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Opportunities for Domestic Manufacturers

Manufacturers do not need to be "recyclers" to pursue supply chain opportunities. The industry is built around an ecosystem of waste management collection and sorting, petrochemical and chemical processing and refining, and plastics manufacturing. As such, supply chain opportunities center on industrial needs for equipment, logistics, and consumers of feedstock.

EQUIPMENT MANUFACTURING

Advanced recycling plants are essentially chemical refineries that require domestic manufacturing of specialized industrial equipment, including pyrolysis reactors, extruders, pelletizers, and high-viscosity pumps.

Target NAICS:

- **333220:** Plastics and Rubber Industry Machinery Manufacturing (Specific code for extruders, molding machinery).
- **33391:** Pump and Compressor Manufacturing.

ACCESS TO SUSTAINABLE FEEDSTOCKS

Companies engaged in circular plastics are looking to secure long-term supply agreements for post-consumer recycled content to hedge against volatility in fossil-fuel-based resin prices, advance ESG commitments and meet customer sustainability mandates (e.g., Walmart, Target packaging requirements). There is an opportunity to engage with suppliers who are certifying resins via **ISCC PLUS** (International Sustainability & Carbon Certification) or **APR PCR Certification**. [8]

Target NAICS:

- **325211:** Plastics Material and Resin Manufacturing
- **423930:** Recyclable Material Merchant Wholesalers
- **424610:** Plastics Materials and Basic Forms and Shapes Merchant Wholesalers
- **541620:** Environmental Consulting Services
- **562920:** Materials Recovery Facilities (MRF)

LOGISTICS & REVERSE LOGISTICS

The circular plastics economy requires moving material throughout the entire supply chain, creating a need for specialized transport and consulting. This includes post-use plastics collection and aggregation, and processing, feedstock conversion, polymerization and purification, and manufacturing.

This includes waste collection and transportation of post-use plastics in bales or other delivery forms, and moving sorted materials to mechanical recycling locations and feedstocks for conversion to advanced recyclers. These logistics typically rely on truck or rail transportation to sortation and aggregation facilities.

Transporting recycled feedstocks for processing to facilities such as steam crackers and other polymerization manufacturing plants can utilize truck, rail, or pipeline transportation.

The final product, virgin-quality plastic resin pellets, needs to be transported to manufacturing facilities, often in specialty-designed rail cars, trucks, or containers.

Target NAICS:

- **562111:** Solid Waste Collection
- **562112:** Hazardous Waste Collection
- **482110:** Rail Transportation
- **482111:** Line-Haul Railroads
- **484230:** Specialized Freight Trucking, Long-Distance
- **484220:** Specialized Freight Trucking, Local
- **488210:** Support Activities for Rail Transportation
- **493110:** General Warehousing and Storage
- **541614:** Process, Physical Distribution, and Logistics Consulting Services
- **541620:** Environmental Consulting Services
- **541618:** Other Management Consulting Services
- **541330:** Engineering Services

Policy and Sustainable Manufacturing Transition

The transition to **sustainable chemical manufacturing** is a significant new market opportunity, accelerated by policy and brand demand. [10]

While federal environmental policy has slowed the acceleration driving sustainability through mandates and regulations, state-specific policies are rapidly changing the economic landscape to advance the circular plastics investment and new technology deployment.

As of December 2025, more than 25 states have classified Advanced Recycling as a manufacturing process (rather than waste management), which clarifies the regulatory burden and accelerates deployment. Additionally, Extended Producer Responsibility (EPR) policies at the state level are driving demand for recycled materials.

Seven States with Comprehensive EPR for Packaging
Maine (2021), Oregon (2021), Colorado (2022), California (2022), Minnesota (2023), **Maryland (2025)** and **Washington (2025)** have enacted laws requiring producers to finance and manage the recycling or safe disposal of their packaging. In 2025 alone, 12 states have introduced EPR legislation in some form. [11]

EPR programs are increasingly seen as a tool to address recycling challenges and reduce single-use product pollution. Recent legislative pushes aim to expand cost coverage beyond basic collection and processing to include:

- **Outreach and Education** for consumers.
- **Infrastructure Improvements** for recycling facilities.
- **End-Market Development** for recycled materials.

In short, EPR shifts the financial and management burden of recycling from local governments and taxpayers to the **producers** who design and introduce the materials to the market.

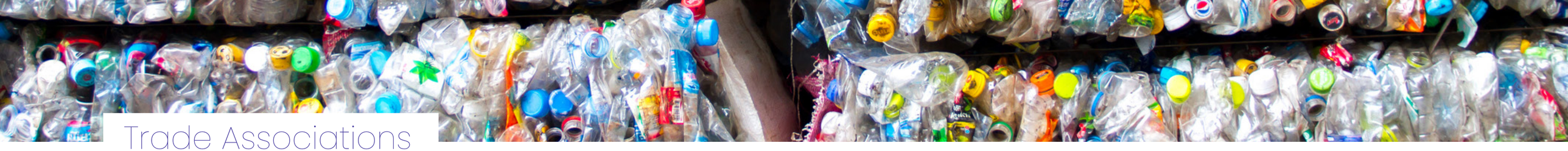
Federal Policy as an Investment Catalyst
Federal and state policy can play a supportive role in de-risking investments targeted toward sustainability, providing stability against any short-term macroeconomic challenges. Federal programs that have been protected in the new administration have the potential to drive billions of dollars in investment across heavy industry sectors, including chemicals.

The most impactful incentive for basic chemical manufacturers is the Section 45Q tax credit, which supports Carbon Capture, Utilization, and Storage (CCUS).[7] Analysis shows that even marginal increases in this credit can significantly expand deployment. [12]

Traditional Regulatory Frameworks
The chemical sector operates under a comprehensive set of established federal environmental and safety regulations. These include the Resource Conservation and Recovery Act (RCRA, 1976), the Clean Air Act (CAA, 1963), the Occupational Safety and Health Act (OSHA, 1970), and the Toxic Substances Control Act (TSCA, 1976).

TSCA is particularly relevant in the context of circular plastics, as it grants the U.S. Environmental Protection Agency (EPA) the authority to regulate chemical substances that present an unreasonable risk to health or the environment. Specifically, TSCA regulates the manufacture, processing, distribution, use, or disposal of certain existing chemicals, and requires notification for new chemicals.[13]

As materials derived from advanced recycling processes are often chemically identical to virgin inputs but require new processing, TSCA compliance is a critical consideration for manufacturers looking to integrate these novel feedstocks.



Trade Associations

The U.S. circular plastics landscape is split between two main groupings: chemical (advanced) recycling advocates and mechanical recycling advocates.

The following organizations are the key players at the national, regional and state levels.

NATIONAL TRADE ASSOCIATIONS

American Chemistry Council (ACC) – Plastics Division: America's Plasticsmakers are working to advance advanced recycling (chemical recycling) technologies at scale by advocating for focused and science-based federal and state policies.

Plastics Industry Association (PLASTICS): Represents the entire supply chain (equipment, material suppliers, brand owners). It runs the **Advanced Recycling Committee** and advocates for both mechanical and chemical recycling technologies.

Association of Plastic Recyclers (APR): It publishes the APR Design® Guide, which dictates how packaging must be made to be recyclable. If you manufacture plastic packaging, you likely need their certification.

Recycled Materials Association (ReMA): Formerly known as ISRI. Represents the scrap and recycling facilities that physically process materials. It handles the "commodities" side of the trade (bales of PET, HDPE, etc.).

U.S. Plastics Pact: Not a trade association per se, but a high-profile consortium of brands (Coke, Walmart, etc.) and NGOs committed to meeting 2025 circularity targets.

STATE & REGIONAL "CHEMICAL COUNCILS" (ADVANCED RECYCLING FOCUS)

These state chapters of the chemical industry are the most active groups advocating for advanced recycling policies at the state level.

- Chemical Industry Council of California (CICC)
- Chemical Industry Council of Delaware (CICD)
- Chemistry Council of New Jersey (CCNJ)
- Illinois: Chemical Industry Council of Illinois (CICI)
- Louisiana Chemical Association (LCA)
- Michigan Chemistry Council (MCC)
- New York State Chemistry Council (NYSCC)
- Ohio Chemistry Technology Council (OCTC)
- Pennsylvania Chemical Industry Council (PCIC)
- Texas Chemical Council (TCC)

REGIONAL RECYCLING & CIRCULARITY ALLIANCES

These organizations are often coalitions of state governments and private companies and tend to be more technology-neutral or focused on **mechanical recycling** and collection infrastructure (MRFs).

- **Northeast Recycling Council (NERC):** A multistate nonprofit. It operates the CIRCLE Coalition, specifically focused on increasing the circularity of plastics in the life sciences and health care sectors.
- **Circular Great Lakes (CGL):** A regional initiative managed by the Council of the Great Lakes Region, focused on plastic waste management and building a closed-loop economy for plastics in the region (active in MI, OH, WI, IL, MN).
- **Western Plastics Association (WPA):** Represents the plastics industry across the Western U.S. and Canada. It bridges the gap between policy (like California's SB 54) and processors.
- **California Product Stewardship Council (CPSC):** A strong advocate for Extended Producer Responsibility (EPR).
- **Association of Oregon Recyclers (AOR):** Active in the Pacific Northwest; often leading the nation in progressive recycling policy.
- **Southeast Recycling Development Council (SERDC):** Focuses on connecting manufacturers in the South (home to many carpet and textile mills) with recycled feedstock.
- **Carolinas Plastics Recycling Council (CPRC):** A bistate council (NC/SC) focused on recovering bottles and rigid plastics for the heavy manufacturing base in the Carolinas.

Conclusion: Accelerating Manufacturer Opportunity in Circular Plastics

The convergence of Advanced Recycling technology, federal and state policy, market demand and industry sustainability goals creates emerging market opportunities for manufacturers across the entire supply chain.

In short, advanced recycling offers the technical solution for high-quality circularity, while EPR and Mass Balance provide the commercial and regulatory certainty necessary for manufacturers to invest, innovate, and thrive in the growing sustainable materials market.

Market demand and supportive policies are fueling advancements in circular plastics, generating economic investment and growth across the chemical manufacturing supply chain.

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CIRCULAR PLASTICS SUPPLY CHAIN: OVERVIEW

Circular Plastics Supply Chain: Overview was drafted by Steven Kratz. Kratz serves as the president of the Pennsylvania Chemical Industry Council (PCIC), the premier statewide business organization representing the commonwealth's chemical industry. Working closely with the PCIC board of directors and council staff, Kratz oversees all operations, advocacy and initiatives of the council. As PCIC president, Kratz collaborates with staff and members to foster an economic and regulatory environment that encourages investment and growth in technology and innovation, and advances the chemicals and related industries as a whole.

In addition to his role with PCIC, Kratz is a senior director for Bravo Group, a Harrisburg-based national public affairs and communications firm. With experience in manufacturing, energy, infrastructure and other highly regulated industries, integrated advocacy campaigns, and state economics and political issues, Kratz works to advance clients' community and business interests and enhances economic development opportunities.

Steven brings nearly 20 years of political, advocacy and economic development marketing experience to the council, with an extensive background in advancing projects, policies and initiatives, and leading diverse coalitions. He served as the director of communications and press secretary for the Pennsylvania Department of Community & Economic Development and led or supported several political campaigns in southeast Pennsylvania and the Lehigh Valley. He is a graduate of Lebanon Valley College.