U.S. PLASTICS PACT™

Position on the Role of Physical and Chemical Recycling in a Circular Economy for Plastic Packaging

Addressing the responsible integration of physical and chemical recycling within a broader system designed to advance a circular economy by reducing plastic waste and reliance on virgin plastic

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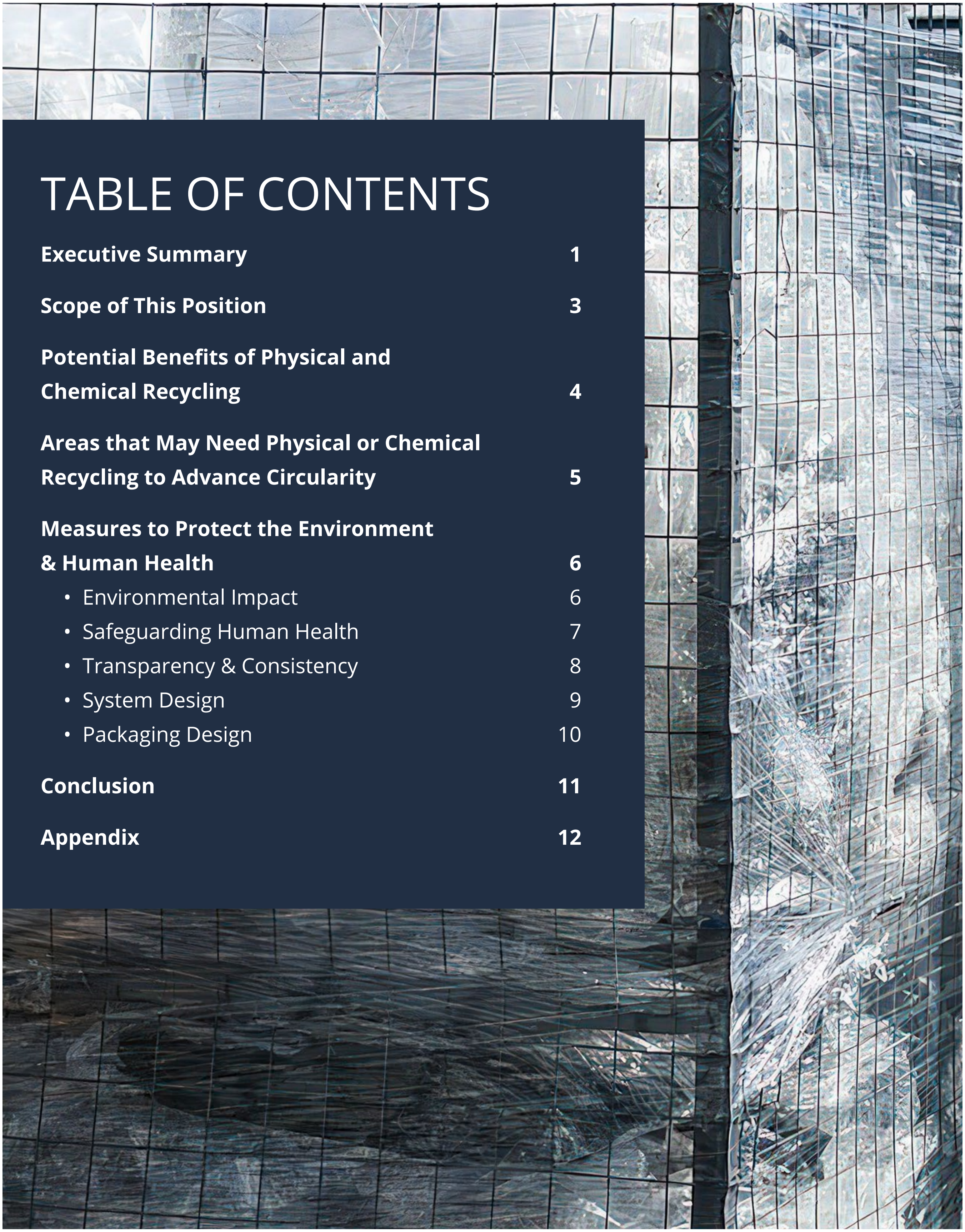

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EXECUTIVE SUMMARY

Public interest in physical and chemical recycling technologies has grown alongside increasing concern over plastic waste. While these technologies are not new, recent efforts to scale them for industrial use have accelerated. Evaluating both their benefits and their associated concerns is essential to determining their appropriate role in advancing a circular economy for plastic packaging.

Traditional mechanical recycling relies on washing, shredding, and extruding material to make recycled plastic that can be used in new items. Physical and chemical recycling processes use solvents, heat, and/or chemicals to remove contaminants or break down plastics into their molecular components. These methods can often handle materials that are difficult to mechanically recycle and may yield higher quality outputs. However, their operational processes also tend to be more costly and carry greater environmental impacts[1,2,3].

As these technologies evolve, it is critical to establish clear policy frameworks and performance standards...

As these technologies evolve, it is critical to establish clear policy frameworks and performance standards to ensure they contribute meaningfully to reducing virgin plastic use and advancing circularity, without compromising environmental or public health.

The U.S. Plastics Pact supports the responsible integration of physical and chemical recycling within a broader system designed to advance a circular economy by reducing plastic waste and reliance on virgin plastic. These technologies may offer solutions for specific hard-to-recycle formats but must not displace efforts focused on reduction, reuse, or mechanical recycling. To guide their responsible development, the U.S. Pact has established key principles and safeguards, including:

- Use the EPA's Waste Management Hierarchy, to prioritize solutions with lower environmental impact – starting with reduction, then reuse, followed by mechanical recycling, and finally physical or chemical recycling for formats that cannot be addressed otherwise. Packaging redesign efforts should align with this hierarchy as well.
- A systems-level view should be taken when considering the role of these technologies to maximize benefits.
- Physical and chemical recycling should complement, not duplicate or replace, mechanical recycling and be used in instances where mechanical recycling is not feasible or insufficient.
- These technologies may offer circular solutions for hard to recycle plastic packaging – particularly films/flexible plastic and food-contact applications.
- Technology of recycling processes is only one piece of a circular economy. Additional innovation is needed in collection & sortation, consumer labeling, and circular packaging design.

[1] Closed Loop Partners, *Transitioning to a Circular System for Plastics: Assessing Molecular Recycling Technologies in the United States and Canada*, https://www.closedlooppartners.com/foundation-articles/assessing-molecular-recycling-technologies-in-the-united-states-and-canada/
[2] Eunomia, *Chemical Recycling: State of Play*, https://eunomia.eco/reports/final-report-chemical-recycling-state-of-play/
[3] U.S. Dept. of Energy, *Environmental and Economic Implications of Emerging Plastic Recycling Technologies*, https://docs.nrel.gov/docs/fy23osti/87159.pdf

- While all recycling and manufacturing processes carry environmental impacts, physical and chemical recycling typically have higher footprints than mechanical recycling due to the use of solvents, chemicals, and energy-intensive methods[1,3]. To ensure these technologies contribute meaningfully to circularity while minimizing environmental and human health risks, robust standards and safeguards are essential. These include:
    - **Environmental**
        - Development of best regulatory practices, including financial mechanisms for funding potential environmental cleanup or remediation.
        - Implementation of good manufacturing practices to ensure safe chemical handling, waste minimization, and responsible disposal.
        - Use of fair and transparent lifecycle assessments (LCA) or environmental benchmarks in evaluating facilities to confirm lower environmental impact compared to virgin plastic production. These assessments should be verified by an independent third party for credibility.
    - **Human health**
        - Avoid siting facilities in environmental justice communities and assess cumulative impacts in siting decisions.
        - Provide cumulative emissions testing and any necessary remediation.
        - Prioritize local communities for benefits such as infrastructure and job opportunities.
        - Ensure transparency in air and water emissions and adequate environmental management systems at all facilities.
    - **Ensuring transparency and consistency**
        - Create a standardized measurement system for calculating recycling tonnages for all recycling processes.
        - Require third-party, chain of custody certification of all postconsumer recycled content (PCR) created through physical or chemical recycling. Additional parameters on mass balance calculation methods are detailed below.
        - Develop a third-party certification for responsible production standards.
        - Waste-to-energy or fuel processes should not be considered material recycling.

Guidance on good manufacturing practices, best practices in regulation, and considerations for environmental trade-offs should be based on science...

- Guidance on good manufacturing practices, best practices in regulation, and considerations for environmental trade-offs should be based on science and regularly updated as research emerges.

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[1]Closed Loop Partners, *Transitioning to a Circular System for Plastics: Assessing Molecular Recycling Technologies in the United States and Canada*, https://www.closedlooppartners.com/foundation-articles/assessing-molecular-recycling-technologies-in-the-united-states-and-canada/
[3]U.S. Dept. of Energy, *Environmental and Economic Implications of Emerging Plastic Recycling Technologies*, https://docs.nrel.gov/docs/fy23osti/87159.pdf

SCOPE OF THIS POSITION

Chemical recycling is a complex subject within the broader conversation on achieving a circular economy for plastic packaging. The terminology itself – such as "chemical recycling," "advanced recycling," and "molecular recycling" – is inconsistently applied, creating misunderstandings and challenges in aligning on solutions. A diverse range of technologies fall under these labels, necessitating clearer classification to facilitate productive dialogue. The U.S. Pact adopts the terminology framework under development from the International Standards Organization (ISO) ISO/CD 15270-1.3, which categorizes recycling into four types: mechanical, physical, chemical, and organic/biological. Standardizing these terms is critical for transparent, evidence-based discussions and accurate evaluation of risks and benefits.

A brief description of the various recycling processes relevant to this position follows. Additional details on these processes may be found using the links in the Appendix.

- **Mechanical** recycling is the traditional recycling process and typically involves washing, shredding, and extruding the materials. The wash process is used to remove surface contaminants, and the polymer structure of the plastic is not changed.
- **Physical** recycling uses solvents to separate the contaminants from the plastic. The polymer structure of the plastic is not changed.
    - This category includes Purification and Dissolution technologies.
- **Chemical** recycling uses heat and/or chemicals to break down the plastic polymers into their molecular building blocks. These processes can vary significantly by type and facility. Some chemical recycling processes produce both an oil that is used to create feedstock for new materials as well as byproducts used for fuel.
    - This category includes Depolymerization technologies (such as solvolysis) and Conversion technologies (such as pyrolysis).

This position paper focuses on physical and chemical recycling processes only. *Waste-to-fuel or energy processes are not considered* material recycling *and are not in scope*. The subsequent "Transparency and Consistency" section addresses provisions for chemical recycling processes that create feedstock for new materials as well as byproducts that are fuel or used to create fuel.

POTENTIAL BENEFITS OF PHYSICAL AND CHEMICAL RECYCLING

The Ellen MacArthur Foundation defines a circular economy as a system where materials never become waste and nature is regenerated. In plastic packaging, this means keeping materials in continuous circulation – avoiding landfills, combustion/incineration, and environmental leakage – while reducing reliance on finite resources for virgin plastic. Although mechanical recycling is effective in many cases, it does have limitations. In such instances, physical and chemical recycling may offer valuable, complementary solutions.

Physical and chemical recycling processes potentially offer the following benefits:

- **Capturing more materials**
    - These technologies may enable the recovery of materials that are otherwise difficult or impossible to recycle mechanically, including certain challenging packaging types and non-packaging plastics such as textiles.
    - While plastics can be mechanically recycled multiple times, material quality eventually degrades due to residual contamination and repeated heating cycles. As chemical recycling breaks down the polymers to the molecular level, some processes may extend the useful life of these polymers when they can no longer be mechanically recycled[2].
- **Unlocking additional applications that can use PCR**
    - Physical and chemical recycling use heat and/or chemicals, which can remove more contaminants than just washing the plastic, providing an opportunity to use PCR in some food-contact or medical-grade packaging with stringent quality requirements that cannot otherwise use PCR, according to FDA condition of use[1].
- **Reducing reliance on virgin plastic**
    - By enhancing the recovery and quality of recycled plastics, physical and chemical recycling contribute to the reduction of virgin plastic usage, decreasing the need for fossil fuel extraction.
- **Supporting the economics of all recycled content**
    - Some material received by MRFs or recyclers that is unsuitable for mechanical recycling, and consequentially sorted out to be disposed of, could instead be sold to physical or chemical recyclers.

The U.S. Plastics Pact supports the integration of these technologies as a complementary and necessary component to achieving a circular economy for plastics and reducing the use of virgin plastics. However, due to potential risks, appropriate safeguards must be implemented to protect human health and the environment.

[1]Closed Loop Partners, *Transitioning to a Circular System for Plastics: Assessing Molecular Recycling Technologies in the United States and Canada*, https://www.closedlooppartners.com/foundation-articles/assessing-molecular-recycling-technologies-in-the-united-states-and-canada/
[2]Eunomia, *Chemical Recycling: State of Play*, https://eunomia.eco/reports/final-report-chemical-recycling-state-of-play/

AREAS THAT MAY NEED PHYSICAL OR CHEMICAL RECYCLING TO ADVANCE CIRCULARITY

> ***Guidance on good manufacturing practices, best practices in regulation, and considerations for environmental trade-offs should be based on science...***

Certain packaging formats present challenges that reduction, reuse, and mechanical recycling alone cannot resolve. While not exhaustive, these examples underscore priority areas where physical and chemical recycling are necessary in achieving full circularity. Plastic waste extends beyond packaging, requiring a systems-level approach to develop circular solutions for a broader range of plastic products. Expanding the focus beyond packaging at the systems-level may unlock recycling opportunities for more types of plastic in addition to increasing efficiencies for physical or chemical recycling of plastic packaging. Areas listed outside of the USPP's scope should not be considered recommendations but rather considerations for industry and policy makers in developing an effective overall system to advance a circular economy for all materials. The USPP recommends that the waste hierarchy be followed in all areas – first prioritizing reduction or reuse efforts, followed by mechanical recycling where possible, and then physical or chemical recycling.

- **Films and Flexible Plastic Packaging:** Even with many conversion efforts to Polyethylene and Polypropylene film structures that meet recyclability design guidelines and industry efforts to support and grow end markets for the collected material, mechanically recycled films currently still have limited circular end market opportunities, especially in food contact packaging. Therefore, mechanical, physical, and chemical recycling processes will be needed to achieve circularity in this area.
- **Certain Food Packaging Applications:** Due to difficult-to-remove food residue or strict safety requirements in complex packaging formats (e.g., films, heat-treated applications, polypropylene containers, or PET thermoforms), not all food packaging can be effectively processed through mechanical recycling.
- **Additional areas for consideration[2] (outside the USPP's scope):**
  - Medical Packaging: Plastics used in clinical, hospital, and research settings fall outside the U.S. Plastics Pact's scope but still contribute to plastic waste. While some materials may be suitable for mechanical recycling, others require the use of chemical recycling due to health and safety concerns.
  - Textiles: Materials such as clothing and carpet are often difficult to mechanically recycle. Chemical recycling technologies that process polyester textiles can also handle PET packaging, potentially improving economies of scale. However, chemical recyclers should avoid processing items easily handled by mechanical recycling, such as PET bottles.
  - Products and Durable Goods: A significant amount of plastic is used in various products and durable goods, such as toys, automobile parts, home construction materials, electronics, etc. The complexity of material types may necessitate physical or chemical recycling.

[1]Closed Loop Partners, *Transitioning to a Circular System for Plastics: Assessing Molecular Recycling Technologies in the United States and Canada*, https://www.closedlooppartners.com/foundation-articles/assessing-molecular-recycling-technologies-in-the-united-states-and-canada/
[2]Eunomia, *Chemical Recycling: State of Play*, https://eunomia.eco/reports/final-report-chemical-recycling-state-of-play/

MEASURES TO PROTECT THE ENVIRONMENT & HUMAN HEALTH

All manufacturing and recycling processes carry potential environmental and human health risks, necessitating proactive measures to mitigate these impacts. In the context of physical and chemical recycling, common concerns include potentially higher carbon emissions compared to mechanical recycling, air and water pollution, generation of hazardous waste, low material yields, byproducts used as fuels or for production of fuels rather than materials, and issues related to environmental justice. To ensure these technologies contribute positively to a circular economy, it is essential to prioritize systems and business practices that both maximize circular outcomes and uphold strong environmental and public health safeguards.

The following list reflects the most critical priorities for both the industry and policy makers to address as these systems scale. The list is organized by topic, not order of importance.

Environmental Impact

Physical and chemical recycling processes should have a lower environmental impact than virgin plastic manufacturing, confirmed through transparent, science-based assessments.

- Physical and chemical recycling processes are intended to be complementary solutions within the waste hierarchy – used when reduction, reuse, and mechanical recycling efforts are not feasible. Therefore, the appropriate baseline to use for comparison of the environmental impact from physical or chemical recycling processes is virgin plastic manufacturing with non-circular end-of-life options (in the United States, this is mainly landfilling).
- Physical or chemical recycling processes and facilities should be designed and operated to achieve a lower environmental footprint than producing virgin plastics, as demonstrated through robust lifecycle assessments (LCA's). Parameters for LCA's are further discussed in the Transparency & Consistency section.
- Some technologies may demonstrate the potential for significant improvement over time due to scale up and process optimization. Any assumptions used to describe potential future improvements should be realistic and transparently communicated to drive the necessary actions to achieve this potential.
- Guidance on environmental trade-off considerations, in both policy and individual company actions, should be regularly revisited and updated as more data and information become available.

Facilities should employ best practices and good manufacturing processes to ensure safe utilization of feedstocks, intermediates, and outputs while managing emissions and handling waste streams safely and appropriately.

- At a minimum, these practices and processes should include:
    - Safe chemical selection & handling protocols
    - Responsible handling of intermediates
    - Minimizing the amount of waste that is generated, particularly hazardous waste, and safe handling practices for the waste that is generated
    - Standards for safe chemical manufacturing practices for any outputs generated from these processes

Appropriate permitting should be in place.

- The full recycling process, from the point of collection until the incorporation of PCR into a new item, includes both solid waste management and manufacturing. However, due to varying levels of vertical integration, some facilities may not manage both. As a result, environmental and human health safeguards must be evaluated at the facility level to ensure site-specific risks are properly addressed, rather than relying on generalized assumptions.
- All recycling sites should follow all local, state, and federal regulations and be registered with the EPA. Relevant permits should be filed to provide transparency on risk and risk mitigation measures.

Best regulatory practices for physical and chemical recycling should be developed.

- Given that the industry is relatively early in the scaling up process, states are still learning how to best regulate these technologies. A handful of states, such as Ohio, have multiple physical or chemical recycling sites and learnings from these states may serve as a policy model for others in the future.
- An emerging best practice is proactive funding to cover environmental cleanup or remediation efforts in the event of an accident through mechanisms such as insurance requirements for facilities or required ongoing contributions to dedicated bond funds.

Safeguarding Human Health

Environmental Justice considerations should be included in all siting decisions.

- New facility sitings should avoid Environmental Justice communities as identified by California's Enviroscreen, archived versions of the EPA's EJ Screen, or the Climate and Economic Justice Screening Tool.
- The U.S. Plastics Pact strongly supports the federal government resuming work to identify environmental justice communities and providing this information for companies to use in siting decisions.
- Cumulative impacts (defined by the EPA as the totality of exposures to combinations of chemical and non-chemical stressors and their effects on health, well-being, and quality of life outcomes) of all industry in the area should be considered in siting decisions to ensure that no community is overburdened by the adverse effects of multiple sites.

Communities should be engaged in decision making.

- Facilities should commit to fair treatment and meaningful involvement of nearby communities, including early and on-going community engagement with decision making input.
- Nearby communities should share in the positive outcomes from investment in physical or chemical recycling facilities by prioritizing these communities for jobs, community investment, pollution reduction efforts, etc.

Water and Air Emissions should be minimized to protect nearby communities.

- All recycling facilities should be transparent about air and water emissions, including all required permits and variances. Companies should have an environmental management system that is compliant with ISO 14001 as well as clear commitments to protect the local community and transparent reporting on adherence to those commitments.
- Facilities should provide or fund cumulative emissions testing in surrounding communities, transparently reporting results. If emissions exceed recommended thresholds, companies must assist in implementing reduction measures and community risk mitigation strategies.

Transparency & Consistency

Recycled content should be certified using chain of custody certification standards.

- Only processes that lead to the creation of feedstock for new materials, energy and fuel excluded, should be considered recycling per ISO 18604 definitions.
- Physically or chemically recycled material should be certified using a standard that complies with ISO 22095 chain of custody standards, ideally aligning with the U.S. Plastics Pact PCR Certification Principles.
- Mass balance calculations should use Proportional, Non-Proportional – Polymers Only, or Non-Proportional – Fuel-exempt accounting allocation methods[4]. Transparency is crucial for building trust in the process, so accounting allocation methods should be disclosed. Over time and with scale up, accounting allocation methods should move from less restrictive methods to more precise methods, as has been observed in other industries utilizing mass balance processes (such as Responsibly Sourced Palm Oil).
- Postconsumer recycled content[*] and pre-consumer recycled content[**] (also called postindustrial recycled content) should be separately calculated and disclosed.

Environmental impact comparisons should be transparent and fair.

- Environmental impact comparisons should be based on accurate and transparent data.
- Appropriate parameters should be used in LCA's or benchmarks comparing the impact of chemical or physical recycling facilities to virgin plastic manufacturing:
  - Use functionally equivalent boundary conditions (i.e. starting and ending points).
  - Virgin plastic should include the impact of fossil fuel extraction.
  - Appropriate emissions from transportation of materials across the full life cycle should be included to ensure consistent comparisons.
  - If incineration avoidance credits are used in the comparison, they should reflect realistic estimates of how much plastic is incinerated in the geography that the feedstock is sourced from.
  - If byproducts and coproducts are included for physically or chemically recycled plastic, they should be included in the material that it is being compared to.
  - All credits used in the comparison should be clearly stated and reflect realistic estimates.
- LCA comparisons should be completed using ISO 14040 and 14044 parameters.

[4]National Institute of Standards and Technology, U.S. Department of Commerce, *An Assessment of Mass Balance Accounting Methods for Polymers Workshop Report*, https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1500-206.pdf

*Postconsumer recycled content: Proportion, by mass, of postconsumer (1) recycled material in a product or packaging. Note 1. ISO14021's usage of the term clarifies postconsumer material as material generated by households or by commercial, industrial and institutional facilities in their role as end users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain. (ISO 14021)

**Pre-consumer recycled content: Proportion, by mass of pre-consumer (1) recycled material in a product or packaging. Note 1. ISO 14021's usage of the term clarifies pre-consumer material as material diverted from the waste stream during a manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed with the same process that generated it. (ISO 14021)

The industry should be transparent about yield losses.

- All recyclers and those using outputs from recyclers should be transparent about the amount of feedstock for raw materials that is generated through their processes and what is lost as waste or byproducts. Some processes may have realistic potential to reduce yield losses over time based on emerging technologies, investments or process improvements. Organizations should be transparent about future potential improvements and the assumptions they are based on.
- Physical and chemical recyclers should strive for greater transparency and alignment in bale specifications, following the example set by the mechanical recycling industry. Clear understanding of acceptable materials will accelerate consensus and drive the packaging redesigns needed to support a circular economy.

A measurement standard for calculating recycling tonnages is critically needed.

- A standard measurement process for calculating recycled content, including standard measurement points, should be developed in the US as has been done in other countries, such as Canada.
- Consistent reporting is critical for measuring overall industry progress and building trust in the system.

A third-party certification of responsible production standards would reduce risks and maximize circularity impact.

- Establishing a comprehensive responsible production standard, supported by third-party certification, would enhance transparency, ensure accountability, and promote circularity while minimizing environmental and human health risks.

System Design

Physical and chemical recycling systems should complement existing mechanical recycling systems, not replace or duplicate them.

- Because physical and chemical recycling systems have a meaningfully larger impact on energy usage, carbon emissions, and other pollutants, mechanical recycling should be pursued first whenever possible.
- Complementarity to mechanical recycling can be realized through:
    - Accepting lower-quality or more variable materials that are unsuitable for mechanical recycling, such as the areas listed in the "Recommended Areas for Chemical Recycling" section above.
    - Generating higher quality feedstock suitable for plastics used in applications with more stringent requirements such as medical, pharmaceutical, food-grade, or toys.
- Scaling up physical and chemical recycling should increase the total volume of plastic packaging collected and recycled, surpassing the current capacity of mechanical recycling alone, and should not negatively impact the economics of mechanical recycling.

Best practices should be applied to and followed throughout the supply chain.

- Physical and chemical recycling involve multiple steps with varying levels of vertical integration across facilities, which may affect how the principles in this paper apply at each site. Despite these differences, all stages of the value chain should implement chain-of-custody protocols and best manufacturing practices to ensure transparency and accountability.

Continued innovation and investment in sortation technologies is needed.

- As more materials enter the recycling stream, effective sortation becomes increasingly important to reduce contamination and increase yields in all recycling streams. To maintain consumer participation and increase in recycling and minimize confusion, technological advancements should be prioritized over additional sortation requirements for consumers.

A circular economy is a complex system that needs all parts to work together.

- Physical and chemical recycling are only one part of a circular economy. Increasing consumer participation in recycling through clear labeling and effective collection systems is essential to securing feedstock for these processes. Additionally, sustained demand for recycled content is essential to ensure the long-term viability of all recycling processes.

Packaging Design

Follow the EPA's Waste Management Hierarchy.

- Physical and chemical recycling play a role in a circular economy but should not be the primary strategy for end-of-life options. The value chain should first prioritize reduction and reuse, followed by mechanical recycling, and then physical or chemical recycling. This hierarchy maximizes environmental benefits and minimizes plastic loss from the circular system.

- In addition to regulatory body efforts, nonprofit organizations are also working to prioritize waste management levers in a similar manner. The Zero Waste Hierarchy is another tool for prioritizing levers to reduce plastic waste and advance circularity showing a similar place in the hierarchy for physical and mechanical recycling.

Design packaging for mechanical recycling

- Brand owners must continue circular redesign efforts because while physical and chemical recycling processes can typically process some additional contamination or variability in incoming feedstock, it is not a wholesale change from the acceptance criteria for mechanical recycling. Designing for Recyclability in compliance with APR Design Guidelines will benefit all recycling streams through improving efficiencies and decreasing yield loss.
- Designing packaging without chemicals of concern (such as PFA's, phthalates, flame retardants, bisphenols, chlorides) will continue to be important regardless of the recycling process as no recycling process has been shown to fully remove these materials from the PCR[2]. The U.S. Plastics Pact plans to provide additional guidance on chemicals of concern to avoid in plastic packaging in 2026.
- While brand owners should work to design packaging for mechanical recycling, physical or chemical recycling will still be needed due to product contamination, the quality requirements for PCR in certain applications, and challenges in mechanically processing large amounts of highly variable feedstocks.
- Some products with highly sensitive shelf-life requirements lack packaging solutions that meet both application needs and recyclability guidelines. Innovation in packaging design and processing technologies is essential to address these gaps. Physical or chemical recycling may be able to tolerate additional variability in the materials. However, these exceptions should not delay redesign efforts where recyclable solutions are feasible. Designing to the APR Design Guidelines reduces contamination and increases recovery yields across all recycling systems – mechanical, physical, or chemical – improving operational costs and the environmental impact in these processes.

CONCLUSION

Physical and chemical recycling technologies, as defined by the ISO terminology framework, offer promising solutions for hard-to-recycle plastic formats such as flexible films, food-contact packaging, medical materials, and textiles. While they can produce higher-quality outputs, they typically carry greater environmental impacts and are not yet fully scaled. Their integration into the circular economy must be guided by a systems-level approach, aligned with the waste hierarchy, and used only when lower-impact options are not feasible.

To ensure these technologies contribute responsibly to circularity, the U.S. Plastics Pact recommends science-based standards, robust environmental and human health safeguards, and transparent certification practices. Additionally, lifecycle assessments, responsible siting and manufacturing, third-party verification of recycled content, and standardized measurement protocols will improve outcomes and transparency. Investments in other aspects of a circular economy – such as improved collection, sortation, and circular packaging design – continue to be essential. By employing these principles, physical and chemical recycling can play a meaningful role in reducing plastic waste and virgin plastic use while protecting environmental and human health outcomes.

[2]Eunomia, *Chemical Recycling: State of Play*, https://eunomia.eco/reports/final-report-chemical-recycling-state-of-play/

APPENDIX

Approach to Creating This Position

The U.S. Plastics Pact is a multi-stakeholder initiative advancing a circular economy for plastic packaging through collaboration across the value chain. This position statement was developed by a diverse group within the PCR workstream – including brands, retailers, converters, recyclers, and nonprofits – who reviewed a broad range of resources to ensure a balanced perspective. After aligning on key principles, the draft was shared with the broader workstream and Activator base for feedback and consensus-building. While not all Activators may agree on every detail, the final statement reflects broad consensus on the role of physical and chemical recycling in a circular economy, with a strong emphasis on environmental and human health protections.

The list of materials the working group reviewed included:

White Papers

- Canada Plastics Pact: Discussion Paper – A Framework for Evaluating the Role of Chemical Recycling to Support a Circular Economy for Plastics in Canada
- Closed Loop Partners: Transitioning to a Circular System for Plastics – Assessing Molecular Recycling Technologies in the United States and Canada
- CSA Group: Plastics recycling – Definitions, reporting and measuring
- Ellen MacArthur Foundation: Enabling a Circular Economy for Chemicals with the Mass Balance Approach
- Eunomia: Chemical Recycling: State of Play
- Ocean Plastics Leadership Network: Responsible Production Guidelines to Ensure Progressive Advanced / Chemical / Molecular Recycling Operations
- Sustainable Packaging Coalition: Introduction to Chemical Recycling
- Systemiq: Transforming PET Packaging and Textiles in the United States
- The City University of New York: Quantitative Comparison of LCA's on the Current State of Advanced Recycling Technologies
- U.S. Department of Energy: A Primer on Using Analysis to Guide Plastic Circularity
- U.S. Department of Energy: Environmental and economic implications of emerging plastic recycling technologies

Position Papers

- American Chemistry Council (ACC)
- Association of Plastic Recyclers (APR)
- Beyond Plastics
- Consumer Goods Forum (CGF)
- National Recycling Coalition (NRC)
- National Resource Defense Council (NRDC)
- Ocean Conservancy
- Recycled Materials Association (ReMA)
- Sustainable Packaging Coalition (SPC)
- The Recycling Partnership (TRP)
- World Wildlife Fund (WWF)

Terms and Definitions

Circular Economy: An economy that is restorative and regenerative by design. It is focused on economic activity that builds and rebuilds overall system health. (U.S. Plastics Pact)

Material Recycling: Reprocessing, by means of a manufacturing process, of a used packaging material into a product, a component incorporated into a product, or a secondary (recycled) raw material; excluding energy recovery and the use of the product as a fuel (ISO 18604)

Mechanical Recycling: The traditional recycling process involving washing, shredding, and extruding materials. The wash process is used to remove surface contaminants, and the polymer structure of the plastic is not changed.

Physical Recycling: The recycling process that uses solvents to separate the contaminants from the plastic. The polymer structure of the plastic is not changed.

- Dissolution and Purification fall under this category.

Chemical Recycling: Recycling processes that use heat and/or chemicals to break down the plastic polymers into their molecular building blocks.

- Conversion: A process using heat and catalysts to break the bonds in the polymer chain[5]. Outputs include chemical building blocks to create new materials as well as byproducts used to create fuel.
    - Pyrolysis falls under this category.
- Depolymerization: A process using solvents where reverse polymerization reactions transform monomaterial waste plastic into monomers, which can be re-polymerized into new products[5].
    - Glycolysis, Hydrolysis, and Methanolysis, which all fall under the broader term of Solvolysis, are included this category.

Waste-to-Energy or Fuel: Processes that turn materials into energy or fuel instead of new materials. These processes are not considered recycling.

Postconsumer Recycled Content (PCR): Proportion, by mass, of postconsumer (1) recycled material in a product or packaging. Note 1. ISO14021's usage of the term clarifies postconsumer material as material generated by households or by commercial, industrial and institutional facilities in their role as end users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain. (ISO 14021)

Pre-consumer Recycled Content (Post-industrial Recycled Content, or PIR): Proportion, by mass of pre-consumer (1) recycled material in a product or packaging. Note 1. ISO 14021's usage of the term clarifies pre-consumer material as material diverted from the waste stream during a manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed with the same process that generated it. (ISO 14021)

Chain of Custody: Process by which inputs and outputs and associated information are transferred, monitored and controlled as they move through each step in the relevant supply chain. (ISO 22095)

Mass Balance Model: Chain of custody model in which materials or products with a set of specified characteristics are mixed according to defined criteria with materials or products without that set of characteristics. (ISO 22095)

[5]Earth Engineering Center, City University of New York, *Quantitative Comparison of LCA's on the Current State of Advanced Recycling Technologies*, https://ccnyeec.org/wp-content/uploads/2022/10/comparisonOfAdvRecyclingLCAs.pdf

Mass Balance Accounting Methods

- **Proportional Allocation:** A mass balance accounting method based on the assumption that recycled units flow the same way as non-recycled units and therefore have the same distribution among outputs.[4]
- **Non-Proportional (Free) Allocation:** A mass balance accounting method that allows for credits to be freely assigned to any product.[4]
- **Non-Proportional – Fuel-Exempt Allocation:** A mass balance accounting method using non-proportional allocation with a deduction for fuels. Units directed to fuel cannot be counted to other products; recycled units are lost from the system regardless of whether the fuel is used on-site or sold as a product stream.[4]
- **Non-Proportional – Polymers-Only:** A mass balance accounting method using non-proportional allocation where only outputs directly linked to the production of polymers can be freely allocated.[4]

Standards Referenced

ISO 14001:2015 *Environmental management systems – Requirements with guidance for use*

ISO 14021:2016 *Environmental labels and declarations – Self-declared environmental claims (Type II environmental labeling)*

ISO 14440:2006 *Environmental management – Life cycle assessment – Principles and framework*

ISO 14044:2006 *Environmental management – Life cycle assessment – Requirements and guidelines*

ISO 18604:2013 *Packaging and the environment – Material recycling*

ISO 22095:2020 *Chain of custody – General terminology and models*

ISO/CD 15270-1.3 *Plastics – Guidelines for the recovery and recycling of plastics waste*

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