Extended Producer Responsibility for Packaging: Ideas for Integrating Climate Mitigation

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Disclaimer

This document has been developed by the West Coast Climate and Materials Management Forum's Extended Producer Responsibility workgroup. The Forum is a collaboration of state, local, and tribal governments. We have created this document to share views on climate change topics to get readers thinking and talking about new strategies for achieving our environmental goals.

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Introduction

Extended Producer Responsibility (EPR) for packaging is increasingly being considered and/or implemented in various parts of the United States, however the focus is often limited to recycling systems. With its emphasis on climate, the Forum seeks to broaden the considerations of EPR policy to also include climate mitigation. This paper, intended for waste reduction professionals and policy makers, provides options for communities to consider that go beyond recycling for a more comprehensive approach to reducing the environmental impacts of packaging (and printed paper and/or food service ware for those bills that include these items).

The Forum's EPR Committee developed this document with three premises in mind:

> 1) Materials have impacts on the climate across their full life cycle, and most of these impacts occur during manufacture and supply chains, "upstream" of the consumer and waste management system.[1]
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> 2) Recycling should be advanced only to the extent that it is done responsibly, reduces pollution, and conserves resources.[2]
>
> 3) Recycling is necessary but on its own is insufficient to fully address broader environmental challenges, such as climate change.[3,4,5]

Four concepts are presented here for consideration:

Concept One: Fund Waste Prevention and Reuse

The Forum's first concept is to advocate for greater funding for waste prevention and reuse. Historically, there has been inadequate funding to implement waste prevention programs on a large scale.

Reducing waste at the source often results in greater reductions in greenhouse gas (GHG) emissions than recycling or composting the same material at end-of-life. The U.S. Environmental Protection Agency found that about 42 percent of all domestic GHGs are associated with the production, transportation, and disposal of materials and products. Most of these emissions occur during manufacture, or "upstream" of the consumer, and cannot be reduced through recycling alone.[6]

EPR bills could include a requirement for Producer Responsibility Organizations (PROs) to fund waste prevention and reuse programs. EPR laws enacted by Oregon and Austria have included such requirements. In Oregon's Plastic Pollution and Recycling Modernization Act, up to 10 percent of collected funds are mandated to fund such programs. Funds can be distributed through a public entity rather than PROs for optimum effectiveness and public benefit.[7]

Funding can be used to evaluate options via pilot projects, or to fund broader shifts in market practices. For example, Oregon has stated that its waste prevention fund – which may generate upwards of $10 million annually – could be used to effectively transition school cafeterias from single-use dishware to reusables; it could also support other dishwashing infrastructure that is critical for rollout of programs that focus on keeping reusable food ware in circulation rather than replacing one type of single-use material with another "less bad" single-use option. These are just two of many examples of projects that could be funded.

Single-use items are sometimes preferred by businesses because they appear to cost less or be more convenient than reusables. Lower costs reflect a failure of market prices to account for the full costs to society of the product's waste and pollution. While some organizations have found that they can save money using reusables, many continue to prefer single use items. A stable funding source via EPR could increase the use of reusables.[8] It would also lead producers to take into account some of the costs their products impose on society.

Concept Two: Set Goals/Mandates for Waste Prevention and Reuse

Including explicit waste reduction goals in EPR for packaging policies is a way for these mandates to broaden their scope beyond recycling and achieve the significant savings associated with the upstream benefits mentioned above. EPR mandates and policies could benefit from clear statements that source reduction and reuse (where applicable) are core to their implementation.

We need to learn how to set targets in ways that are practical, measurable, and which achieve actual environmental benefits. Packaging can provide many valuable services to society (one of which is preventing product damage and reducing product waste), and any prevention mandates need to be designed with the "big picture" in mind. By most metrics, the environmental impacts of many products are significantly bigger than those of their packaging.[9,10,11,12]

Similar caution is needed for reuse targets. While multiple studies show that reuse can reduce environmental impacts associated with single-use products and packaging, the benefits of reuse depend on *how* it is implemented.[13] Depending on the type of material and what it is replacing, the benefits of reusables may hinge on such variables as washing, transportation, and loss rates of reusable items.[14, 15]

While prevention and reuse are generally preferable to recycling, *all* of those practices need to be viewed as *means to an end*, with reduction in pollution (including climate pollution) and conservation of resources being an important goal, potentially a higher priority than landfill avoidance.[16]

Concept Three: Require Evaluation and Disclosure of Environmental Impacts

Policies intended to integrate climate mitigation should focus explicitly on lowering GHG emissions associated with packaging. This requires a standard methodology for evaluating the carbon impact of different packaging alternatives. We know from experience with the U.S. Toxics Release Inventory, Health Product Declarations, reporting of high priority chemicals in children's products, mercury use in products reporting, and life cycle assessments, as examples, that disclosure can be a powerful driver of change.[17,18] So how do we get producers to disclose GHG emissions?

One approach was adopted in Oregon's Plastic Pollution and Recycling Modernization Act (2021). This law creates an incentive for evaluation and disclosure of impacts through mandatory eco-modulation of fees that producers pay to their PRO. The law requires that PROs offer fee reductions for materials that have lower life cycle environmental impacts. Evaluations will have to adhere to new standards (to be established as part of implementation of the Act), which will help bring consistency and comparability to the science of life cycle assessment (LCA) and may also include some of the environmental considerations that LCA does not yet adequately evaluate.[19]

These kinds of disclosure approaches are in their nascent stages for packaging, but examples of their successful use can be drawn from the construction materials sector, including "buy clean" legislation,[20] Health Product Declarations,[21] and standards for lower carbon concrete developed by Marin County, CA[22]; Portland, OR[23]; and others.

Concept Four: Optimize the Recycling System

Recycling and composting typically reduce GHG emissions when compared to the alternatives of landfilling or incineration. For this reason, recycling and composting are often promoted as climate-friendly alternatives. However, this generalization masks three important factors that need to be considered to optimize recycling: a) not all recycling is equally environmentally beneficial; b) some recycling activities have the potential of increasing GHG emissions; and c) "recycling" and "recyclable" are not the same. Optimizing the recycling system to achieve the greatest reduction in GHG emissions is not the same as maximizing recycling rates or aiming to recycle or compost all materials.[24]

Let's briefly examine each of these three factors:

A. **Not all recycling (and composting) is equally beneficial.** The climate benefits of recycling are largely a result of the displacement of virgin resources. Since not all virgin resources are the same, it makes sense that not all recycling is equally beneficial in terms of GHG impacts. This is true both when comparing different materials against each other (e.g., recycling of glass versus recycling of aluminum), and when comparing recycling pathways for the same material against each other. For example, cardboard can be recycled *or* composted, but the recycling pathway offers much greater potential for GHG reduction. Similarly, glass can be recycled via "closed loop" processes back into glass bottles, or via "downcycling" into pozzolan (a cement substitute). The pozzolan pathway requires less energy (and emissions), loses a smaller percentage of collected material during processing, and displaces a much more impactful material (cement), resulting in net climate benefits that are many times higher than recycling glass back into glass bottles.[25]

B. **Some recycling pathways have the potential to increase GHG emissions.** Although these tend to be the exception and not the norm, there are some recycling activities that are best avoided if one's goal is to reduce GHG emissions. For example, modeling by the Oregon DEQ found that drop-off recycling that requires users to transport low-value materials long distances may result in more emissions from personal vehicle use than are offset by the recycling process.[26,27]

C. **"Recycling" is not the same as "recyclable" (and "composting" is not the same as "compostable").** Since recycling and composting are typically more favorable from a climate mitigation perspective than disposal, it seems intuitively reasonable that "recyclable" (and "compostable") items will also result in lower overall emissions. But this common assumption ignores the fact that, for many materials, the impacts of production may be much larger than the potential benefits of landfill diversion via recycling or composting. Further, there can be significant variation in the carbon footprint of different materials and production practices, and these variations can outweigh the GHG benefit of recycling. There are many case studies where "recyclable" or "compostable" items have higher emissions (even when they are recycled or composted) because of how they are made or what they are made of.[28,29] **We should be careful to avoid a future where materials are managed in circular loops but end up *increasing* climate and other impacts. Any incentives or mandates for "recyclable" or "compostable" packaging should be paired with equally strong (or stronger) incentives or mandates for GHG impact evaluation, disclosure, and reduction, so that policy signals aim for a future that is both circular *and* low-impact.** This is an area that is ripe for more policy development.

Summary

The climate emergency threatening our planet requires responses that are both bold and thoughtful. EPR for packaging can and should consider opportunities to better reduce the GHG impacts of packaging. This requires an understanding of the nuances associated with different materials, different discard management pathways, and the sometimes-complex interaction between those pathways and larger emissions sources that occur upstream of the waste management system. Maximizing recycling using traditional accounting (tons diverted from landfill) is not the same as optimizing packaging or the waste management system from the perspective of GHG mitigation. Only through thoughtful evaluation and open-minded discourse will we plot a pathway that results in a future that is both circular *and* sustainable.

The Forum encourages jurisdictions and advocates considering incorporation of climate mitigation strategies into EPR for packaging to work with the Forum to share, develop, and refine policy solutions.

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About the Forum: The West Coast Climate and Materials Management Forum is a collaboration of state, local, and tribal governments developing long-term sustainable materials management practices. We identify and share effective greenhouse gas emission reduction strategies that also improve the way communities source, use, and recover materials. By working together across jurisdictions and disciplines, we demonstrate effective ways for communities to reduce greenhouse gas emissions throughout the life cycle of materials. For more information, visit: https://westcoastclimateforum.com/.

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ENDNOTES

[1] Many states and local governments have conducted consumption-based GHG emissions inventories (CBEI), which estimate the life cycle climate impacts of all goods and services consumed by members of their community. Some CBEIs contain granular data of emissions by life cycle stage. Oregon's CBEI finds that post-consumer disposal of waste contributed less than one percent of total emissions in both 2010 and 2015. See Figure 3-7 of https://www.oregon.gov/deq/FilterDocs/OregonGHGreport.pdf

[2] While recycling typically reduces pollution and conserves resources, the recycling process itself has the potential of creating new impacts. An obvious example is the export of plastics - and bales of paper contaminated with plastics - from the US to countries that lack the legal and/or physical infrastructure to safely manage the materials. Concept Four provides additional examples of where certain end markets or recycling pathways have the potential of causing unnecessary harm or failing to achieve potential benefits.

[3] The US EPA found that while the domestic provision of materials ("goods" and "food") contributed 2,935 million metric tons of CO_2e (42% of domestic GHG emissions) in 2006, increasing the national recycling and composting rate for municipal solid waste from 32.5% to 100% (if possible) would reduce those emissions by only about 300 million metric tons. Recycling 100% of construction and demolition materials would reduce emissions by another 150 million metric tons. Combined, this would represent a 15 percent reduction in emissions associated with materials, leaving the other 85 percent of emissions untouched. See the full report at https://www.epa.gov/sites/default/files/documents/ghg-land-materials-management.pdf. Similar results have been found in separate analyses focused on plastics (see for example https://www.oregon.gov/deq/mm/production/Pages/Water-Bottle-Study.aspx), food, and other materials.

[4] GAIA and Zero Waste Europe found that for plastics, even when using the best recycling technology available, the highest achievable recycling rate is estimated at between 36% and 53%. With current plastic production projections, by 2050, even with a 53% recycling rate, the overall tonnage of plastic pollution in our environment would double. See the full report at https://static1.squarespace.com/static/5f218f677f1fdb38f06cebcb/t/62e9694e1c0e5435f0ba905f/1659464017989/Recycling-is-Not-Enough-UPDATE.pdf.

[5] Project Drawdown has evaluated the global GHG reduction potential of more than one hundred different practices. Focusing just on food, preventing the wasting of food at the source is found to have far greater potential for GHG reductions (102.2 gigatons of CO_2e between 2020 and 2025, under "Scenario 2") than either methane digesters (7.05 gigatons) or composting (1.4 gigatons). See https://drawdown.org/solutions/table-of-solutions.

[6] See EPA report (endnote 3) for details.

[7] The Austria example is cited on page 65 of this document: https://www.oregon.gov/deq/recycling/Documents/recSACmeeting120319.pdf. Oregon's requirement is found in Oregon Revised Statutes 459A.941 and summarized here: https://www.oregon.gov/deq/recycling/Pages/Impact-Reduction-and-Reuse.aspx.

[8] Illinois and New York incorporated reuse funding in their 2023 EPR bills. Find the full Illinois bill here: https://www.ilga.gov/legislation/fulltext.asp?DocName=&SessionId=110&GA=102&DocTypeId=SB&DocNum=3953&GAID=16&LegID=&SpecSess=&Session=. And the New York bill here: https://www.nysenate.gov/node/8381179.

[9] A study conducted by the University of Michigan Center for Sustainable Systems for the Oregon Department of Environmental Quality (ODEQ) reviewed and summarized existing literature regarding the environmental impacts of a variety of foods. The research highlights that packaging plays an important role in protecting food from

damage and contamination and extends the useful life of food items on the retail shelf and at home, thus potentially reducing wasted food and its environmental impacts. Because a large amount of resources go in to producing food, efforts to reduce food waste by increasing packaging can sometimes lead to significant reductions in environmental impact, even when the environmental impact of additional packaging is taken into account. One reason for this is because the greenhouse gas emissions over the life cycle of food packaging are often many times smaller than the emissions associated with producing the food itself. https://www.oregon.gov/deq/mm/food/pages/product-category-level-footprints.aspx. Report on Packaging and Wasted Food: https://www.oregon.gov/deq/FilterDocs/PEF-Packaging-FullReport.pdf

[10] A life cycle assessment conducted at the Department of Civil and Environmental Engineering at the University of California, Berkeley analyzed the food production systems of nine types of produce and found that the impacts from packaging were less than those from production, transportation, and food loss for five out of nine crops. Read the full report at https://www.sciencedirect.com/science/article/abs/pii/S0921344921005541#:~:text=In%20general%2C%20food%20loss%20is,and%20production%207.7%E2%80%9330%25.

[11] An LCA by the University of Michigan Center for Sustainable Systems in partnership with the Michigan State University School of Packaging and Center for Packaging Innovation and Sustainability examining how food packaging affects food waste found that increasing the total packaging impacts for some products resulted in a decrease of overall lifecycle impacts because the impacts from wasted food were greater than those from the total packaging system. Find the full report at https://onlinelibrary.wiley.com/doi/abs/10.1111/jiec.12743

[12] An article in Environmental Science and Technology discusses misperceptions about the impacts of single-use plastic. While plastic packaging is often viewed as highly impactful, studies show that when looking at the entire lifecycle of a product, the production and disposal of the packaging only amount to a few percent of the product's total impact. The majority of the impacts come from the resource extraction, manufacturing, and use of the product, not the packaging. See misperception #1 at https://pubs.acs.org/doi/10.1021/acs.est.0c05295.

[13] Upstream Policy Institute reviewed life-cycle studies comparing the environmental impacts of disposables and reusables, finding that reusable food service ware achieves environmental benefits over the single-use alternatives they replace. The break-even point varies based on the type of material used but the benefits to the environment accrue with each additional use past that point. https://upstreamsolutions.org/reuse-wins-report

[14] Daniel R. Cooper and Timothy G. Gutowski published an article in December 2015 called The Environmental Impacts of Reuse: A Review, noting that the benefits of reuse are typically assumed rather than understood and that consequently the overall effects remain unclear. The article attempts to structure the current work on the topic, review the potential benefits and pitfalls described in the literature and provide a framework for future research. https://onlinelibrary.wiley.com/doi/10.1111/jiec.12388.

[15] The Journal of Industrial Ecology published an article in May 2022 by Maja Wiprächtiger, Martina Rapp, Stefanie Hellweg, Rhythima Shinde, and Melanie Haupt quantifying the impacts of several waste prevention strategies for clothing and furniture in Switzerland. They examine scenarios where the strategies of refuse, reuse, share, sufficiency, and repair are used. The analysis showed that reusing clothes in Switzerland might not be environmentally favorable compared to exporting the clothes for reuse because of the way and frequency secondhand clothes are purchased in Switzerland. The analysis showed the importance of consumer behavior when assessing waste prevention strategies and further emphasized the need to avoid assuming that waste prevention leads to net environmental benefits by default. https://bit.ly/JIE-WP
https://www.linkedin.com/pulse/can-waste-prevention-worsen-environment-reid-lifset/

[16] California's SB 54 (2021) contains waste prevention and reuse targets for plastic packaging. Other states, including Washington and New York, have also seen legislation introduced that includes waste prevention and reuse targets. The targets in SB 54 include mandatory reductions in both weight and number of plastic items. As with most policy innovations, however, there are many implementation details that have yet to worked out, and which might benefit from statutory revisions. For example, the state is required to establish a baseline which is used to assess future compliance (achievement of prevention/reuse goals), but producers have no obligation to report data to the state in time for that baseline to be established. The Act also creates the potential for some unintended consequences whereby in some instances, plastic usage and/or greenhouse gas emissions might actually increase. For example, a transition from a rigid plastic container to a lightweight flexible pouch will reduce plastic use and global impacts of plastic production, including greenhouse gas emissions. But such a change is prohibited by SB 54 in 2032 and subsequent years if the pouch is not recyclable, compostable or reusable. Similarly, a poultry producer may comply with the obligation to reduce the number of plastic items sold into the state by replacing all 6-packs of chicken pieces with 12-packs – this change could reduce the number of plastic items but, especially for 1- and 2-person households, result in an increase in food production and waste (with the climate impacts of poultry production many times higher than the impacts of packaging – see notes 9 and 11). In order to realize an economy that is both circular *and* sustainable, including where greenhouse gas emissions are reduced to sustainable levels, policy needs to explicitly prioritize both objectives and provide a mechanism to resolve potential conflicts between them. EPR legislation should include an explicit policy objective to reduce greenhouse gas emissions. In the absence of such a policy mandate, regulatory agencies and producer responsibility organizations may be drawn to solutions that advance circularity at the expense of the climate.

[17] A report released by the Environmental Protection Agency (EPA) on March 3, 2022, showed a 10% decrease in the release of toxic chemicals covered by the Toxics Release Inventory (TRI) between 2019 and 2020. Each year, more than 21,000 facilities report data to the EPA on over 800 chemicals released into the environment or managed as waste through TRI reporting. Find more information at https://www.epa.gov/newsreleases/new-toxics-release-inventory-data-show-decline-releases-certain-toxic-chemicals.

[18] A report prepared by Quantis for the states of Washington and Oregon surveyed more than one hundred businesses and found that on average, businesses with experience evaluating product footprints do more assessments, take more action, and take more informed action than those without. See https://www.oregon.gov/deq/FilterDocs/QuantisPEFResearchReport.pdf.

[19] See Oregon Revised Statutes 459A.884(4)(c) and (d) for the eco-modulation incentive; ORS 459A.944 for standardization of methods for evaluation and disclosure of environmental impacts and mandated evaluation; ORS 459A.875(2)(j) 459A.897(2)(s) and (t) regarding assessment of the effectiveness of eco-modulation incentive; and this website for additional information: https://www.oregon.gov/deq/recycling/Pages/Life-Cycle-Impact-Evaluation.aspx.

[20] The Buy Clean California Act (BCCA) requires the Department of General Services (DGS) with the California Air Resources Board to set a maximum Global Warming Potential (GWP) limit for structural steel, concrete reinforcing steel, flat glass, and mineral wool board insulation. These materials must have a GWP not exceeding the limits set by DGS when used in public works projects. Read more at https://www.dgs.ca.gov/PD/Resources/Page-Content/Procurement-Division-Resources-List-Folder/Buy-Clean-California-Act.

[21] Health Product Declarations (HPDs) are material ingredient disclosures provided by product manufacturers that can be compared to hazard lists from government agencies or other organizations to assess potential health impacts. More than 800 manufacturers of building product materials now use HPDs to provide material transparency information on more than 40,000 products.

[22] Read County of Marin's Low-Carbon Concrete Requirements here: https://www.marincounty.org/depts/cd/divisions/sustainability/low-carbon-concrete-2022.

[23] Read City of Portland, OR Notice of New Requirements for Concrete: https://www.portland.gov/omf/brfs/procurement/sustainable-procurement-program/documents/city-portland-concrete-embodied/download.

[24] For a scientific critique of some of the popular wisdom involving recycling and environmental impacts, please see Geyer, R., Kuczenski, B., Zink, T. and Henderson, A. (2016), Common Misconceptions about Recycling. Journal of Industrial Ecology, 20: 1010-1017. https://doi.org/10.1111/jiec.12355.

[25] A screening-level LCA of different options for glass recycling can be viewed here: https://www.oregon.gov/deq/recycling/Documents/GlassResults.pdf. This analysis compares 16 different collection scenarios for each of five end-markets: local bottle plant, distant bottle plant, distant fiberglass manufacturer, local pozzolan manufacturer, and local aggregate manufacturer. Slide 88 compares all 80 scenarios against each other for climate impact, showing that in all cases the pozzolan pathway delivers far superior reductions in GHG emissions. Indeed, glass-to-aggregate never reduces GHG emissions, and glass-to-bottles and glass-to-fiberglass only reduce GHG emissions if certain collection and transportation conditions are met. Although glass-to-pozzolan is considered "open-loop" recycling or "downcycling", whereas bottles-to-bottles are an example of "closed loop" recycling or "upcycling", pozzolan delivers equivalent or superior environmental outcomes across most types of environmental impacts (see slides 88 – 99). Geyer et. al's "Common Misconceptions about Recycling" (see prior note) provides additional documentation for why "open loop" recycling ("downcycling") is not necessarily worse from an environmental perspective than "closed loop" recycling.

[26] See https://www.oregon.gov/deq/recycling/Documents/PyrolysisResults071122.pdf for a screening-level life cycle assessment of 20 different disposition pathways for block white expanded polystyrene. For example, slide 21 shows that scenarios where households drive significantly out of their way to deliver polystyrene to a recycling depot ("additional" scenarios 2 and 4) have much higher climate impacts than scenarios where the polystyrene is delivered with no additional impacts (for example, as part of an existing trip; see "marginal" scenarios 1 and 3). Slide 24 holds user behavior constant and compares two different end-markets: a local (in-state) pyrolysis facility (scenario 2) and a distant mechanical recycling option (scenario 4); the distant option actually results in lower GHG emissions, even when the impacts of long-distance transportation are included (so long as the polystyrene is densified first). Slide 25 shows that landfilling the EPS may have slightly higher, equal or lower GHG impacts (depending on transportation conditions) than sending it to pyrolysis, while slide 26 shows that mechanical recycling consistently delivers GHG reductions (even if the recycler is distant and the landfill is nearby).

[27] It should be noted that Oregon's Plastic Pollution and Recycling Modernization Act (2021) also revised the statutory solid waste management hierarchy (see Oregon Revised Statutes 459.015(2)) in several important details. First, in recognition that the hierarchy is often directionally correct but not infallible, the new law supersedes the traditional hierarchy with a higher-order policy objective of reducing "net negative" impacts of materials, across their life cycle, on human well-being and environmental health. The next priority is to reduce the overall quantity of materials used. When information on impacts is not known, it reverts to the traditional policy (reduce first, then reuse, then recycle, etc.), while also subdividing recycling pathways to give preference to those that displace the production of more impactful materials, and processes that best preserve the value and molecular structure of materials being recycled.

[28] See for example an extensive literature review which assessed more than 5,000 comparisons between packaging and food service ware items that had one or more popular attributes of interest (recycled content, recyclable, biobased, or compostable) and functionally equivalent items that did not (or featured the same attribute but less strongly, for example higher vs. lower recycled content):

https://www.oregon.gov/deq/mm/production/pages/materials-attributes.aspx. This study found that with one exception (the attribute of recycled content, and only when comparing against functionally equivalent packages made of the *same* base material), these popular attributes do not consistently align with actual reductions in environmental impacts. Although this study has been critiqued by BPI (see https://bpiworld.org/deq), the critique fails to disprove the basic conclusion: there is a lack of evidence demonstrating that items with one or more of these popular attributes can reliably be assumed to have lower impacts on the environment when impacts across the entire life cycle are taken into account.

[29] Oregon DEQ recognized that a limitation of the study described above was that many LCAs tend to evaluate the world "as it is" as opposed to the world that "could be". The apparent lack of correlation between the attribute of "recyclability" and environmental benefits might be due to sub-optimal conditions for recycling. To test that hypothesis, DEQ conducted original modeling of four different packaging formats that might be used to package coffee: three different recyclable options and a very difficult-to-recycle multi-material flexible pouch. Keeping the impacts of the flexible pouch unchanged (assuming no potential for future improvements), DEQ then modeled a hypothetical scenario where the three recyclable options were recycled at rates of 100 percent – not only for the primary material, but for all lids, closures, and labels. DEQ further biased the analysis in favor of recyclable packaging by assuming that all recycled materials will displace virgin feedstock at a ratio of one-to-one (an unrealistic assumption; as discussed in endnote 24), and that achieving "total recycling" can be done with no higher pollution or per-unit inputs (fuel, for example) than what is attributed to recycling today. Despite these biased and unrealistic assumptions, the recyclable formats, even after crediting the benefits of recycling them at 100 percent, still delivered *higher* impacts than the non-recyclable but highly resource-efficient pouch in 21 out of 24 comparisons (including all comparisons involving climate change). See Figure 5 of https://resource-recycling.com/recycling/2019/09/09/putting-beliefs-to-the-test/.