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Designing Eco-modulation in EPR Frameworks to Support PCR Markets



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EXECUTIVE SUMMARY

Post-consumer recycled (PCR) content plays an important role in advancing recycling targets established under U.S. packaging extended producer responsibility (EPR) laws and supporting investment in recycling infrastructure. However, PCR markets continue to face challenges, including higher costs relative to virgin resin, inconsistent supply, and slowing investment momentum. Eco-modulation—the adjustment of EPR producer fees to incentivize or discourage specific packaging design and material choices—is one potential tool that stakeholders interested in strengthening PCR markets may consider.

In this paper, we share lessons from U.S. and international EPR programs to highlight considerations for how eco-modulation can be structured to support PCR market development. We cover the strategic use of bonuses and maluses, using harmonized criteria to link PCR incentives to recyclability outcomes, and material-specific and application-aware design.

Recognizing that eco-modulation is one of several factors that can influence PCR market development, we also explore complementary conditions that may help create a supportive policy and market environment.

Together, the considerations outlined in this paper— including incentives, recyclability standards, demand dynamics, and infrastructure investment—are intended to inform discussions about regulatory and program design options in support of PCR market development and a more resilient recycling system.

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INTRODUCTION

Growing demand for post-consumer recycled (PCR) content is central to achieving recycling and circular economy objectives embedded in many U.S. extended producer responsibility (EPR) laws. Yet despite increasing policy attention, U.S. PCR markets continue to face structural challenges related to cost competitiveness, feedstock availability, and investment certainty. As jurisdictions consider eco-modulation within EPR programs, stakeholders are seeking greater clarity regarding when and how fee incentives can effectively support PCR market development.

This paper examines lessons from U.S. and international EPR systems and focuses specifically on the design considerations most relevant to strengthening PCR markets. It is not intended to provide a comprehensive framework for eco-modulation; rather, it explores the conditions under which PCR-focused incentives and design criteria may contribute to sustainable market growth.

ECO-MODULATION BASICS

Eco-modulation connects packaging design and material choices to economic incentives within an EPR framework. In practice, base fees are adjusted to reward or discourage specific environmental outcomes aligned with policy priorities, such as reuse, source reduction, toxicity reduction, and improved recyclability. This fee-adjustment approach is often referred to as a bonus-malus structure where producers pay reduced fees (bonus) for meeting preferred design criteria and elevated fees (malus) for falling short. Postconsumer recycled (PCR) content is an eco-modulation factor in enacted U.S. packaging EPR programs and is expected to feature in programs still developing their plans. However, specific financial mechanisms, discount magnitudes, and regulatory mandates vary considerably by state.

Eco-modulation functions as a complement to EPR program elements, such as minimum recycled content requirements or source reduction targets, rather than a substitute for them. Because modification of packaging to receive bonuses or maluses is optional, eco-modulation alone cannot achieve outcomes that haven't been made obligatory elsewhere in EPR program design or other state policy.

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LESSONS LEARNED FROM EXISTING PROGRAMS

International programs offer the clearest evidence of how fee modulation affects real-world outcomes:

- **The effectiveness of eco-modulation depends on the strength of the incentive signal.** When modulation bonuses and maluses are too small relative to the cost of reformulating or redesigning packaging, they are less likely to influence design decisions.[1] Data evaluating European frameworks highlight this limitation.[2]

  As noted by the Organization for Economic Cooperation & Development (OECD), "the amplitude of fee modulation requires careful consideration," because "a small ratio of fee modulation to product price will provide little incentive for Design for Environment (DfE)."[3] When bonuses remain small and voluntary, they tend not to drive broader procurement shifts, instead flowing to producers already using PCR content and lowering fee burdens for some without expanding the market.

- **International frameworks are shifting toward high-magnitude PCR incentives.** Starting January 2026, France's EPR framework introduced structured recycled plastic bonuses for 450 EUR/ton if the recycled content is from a different EPR sector, and 550 EUR/ton if sourced from the same sector[4], creating a substantial financial reward designed to pull material into closed-loop systems.[5] The Netherland's Verpact model doubled its PCR content bonus between 2025 and 2026, making it the single largest individual discount in the scheme, worth twice any recyclability bonus.[6] Both frameworks represent a meaningful shift; as these changes were introduced in 2026, outcome data on producer behavior change is not yet available.

  The same principle applies to maluses. The design features and international examples relevant to malus magnitude and effectiveness are addressed in the section "*Strategic Use of Bonuses and Maluses*" later in this paper.

  The magnitude of modulation should be evidence-based, proportionate to the outcome sought, and periodically evaluated to ensure it is driving behavior change, in this case, recyclable design and the incorporation of PCR content.

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[1] These outcomes reflect how *eco-modulation is calibrated*, rather than the structure or size of EPR fees overall.
[2] Eunomia Research & Consulting & European Commission (2020). Study to support the implementation of reporting obligations on EPR, pp. 42-45.
[3] OECD (2021). Modulated fees for Extended Producer Responsibility schemes (EPR), OECD Environment Working Papers, No. 184, p. 9.
[4] In France's EPR framework, "same sector" refers to material sourced from household packaging waste and returned to packaging applications. "Different sector" refers to PCR sourced from other waste streams, such as industrial or commercial sources.
[5] Household Packaging Rate Guide. CITEO. 2026. P. 51.
[6] Fee Modulation Plastic 2026 Scheme. Verpact. P. 5.

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- **Uncertainty and inconsistency delay investment.** Differences in eco-modulation approaches across jurisdictions create inconsistent market signals for producers. Differences in definitions, material and reporting categories, recyclability criteria, and PCR accounting methodologies create an environment of unpredictability and confusion for producers and recyclers.

  More fundamentally, packaging redesign often requires new material sourcing, testing, regulatory review, and manufacturing line modifications, processing that can take months or even years, depending on material and application. When fee schedules are not published with sufficient lead time relative to these cycles, or change frequently, producers struggle to develop the stable business cases needed to secure capital approvals. As a result, investment decisions may be postponed or ultimately favor maintaining existing packaging formats and material choices rather than pursuing innovation.

  These lessons from existing programs point toward a set of design features that, taken together, make eco-modulation more effective as a PCR market development tool.

HOW ECO-MODULATION CAN SUPPORT PCR MARKETS

- **Strategic Use of Bonuses and Maluses:** Bonuses and maluses serve complementary functions in the PCR context. Bonuses directly stimulate PCR demand by reducing fees for verified PCR content use. Maluses support PCR markets indirectly by discouraging design attributes that reduce the quantity or quality of recyclable feedstock, meaning a design penalty is also, functionally, a supply-side intervention for PCR.

  The international evidence suggests maluses drive behavior change more effectively than bonuses, particularly for eliminating specific problematic packaging features, because a well-calibrated penalty makes non-compliance more expensive than reformulation. France's stepped malus structure for carbon black, beginning at 10%, rising to 50%, and reaching 100%, illustrated this: because carbon black renders packaging undetectable by optical sorters, eliminating it through a malus protects both recyclability and PCR feedstock supply simultaneously. Where disruptive attributes require structural redesign rather than a simple material swap, maluses must be set high enough to make the status quo more expensive than the capital investment required to change it.

- **Simple, technically grounded, harmonized criteria that link PCR incentives to recyclability outcomes:** Two packages may contain identical PCR content, but if one is readily recyclable and the other significantly disrupts sorting or reprocessing, providing the same PCR content bonus to both increases current PCR demand while undermining future feedstock supply. Conditioning a PCR content bonus on minimum recyclability design criteria or allowing a recyclability malus to partially offset the PCR content bonus, aligns current demand incentives with the long-term availability of quality recycled feedstock. This linkage is only enforceable when recyclability is assessed against consistent, technically grounded criteria.

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Existing national systems demonstrate how this works in practice. Spain's Ecoembes model uses a traffic-light system and flow diagrams to make eligibility transparent: the presence of a -disruptive feature or incompatible accessory voids the PCR content bonus, functioning as a de facto recyclability prerequisite.[7] The EU's PPWR reflects this same fundamental design logic by tying EPR fee modulation directly to harmonized recyclability grades (A/B/C), defined by CEN (the European Committee for Standardization) standards such as the EN 18120 series for plastics, which build on RecyClass methodology. RecyClass has maintained a formal harmonization agreement with the Association of Plastic Recyclers (APR) Design Guide in the U.S., which has itself been adopted by Canadian Producer Responsibility Organizations (PROs), creating an increasingly unified standard for design-for-recycling and eco-modulation eligibility. Criteria grounded in these standards are measurable, reportable, verifiable, and auditable.

- **Material-specific and application-aware design:** PET bottles, HDPE containers, PP rigid packaging, EPS, and flexible film[8] have fundamentally different recycling infrastructure realities, cost premiums, and PCR supply chains. The feasibility of incorporating recycled content varies significantly across applications: PCR content availability and quality differ by polymer; food-contact and safety requirements, including the FDA Letter of No Objection process, constrain which materials can use recycled content in certain applications; and legitimate functional requirements across barrier properties, clarity, and structural performance mean that some formats face genuine technical limits on PCR content incorporation that fee signals alone are unlikely to overcome. Uniform incentives applied across all formats either set impossible expectations for difficult materials or over-reward easier ones.

  Effective systems differentiate by polymer and application and acknowledge food-contact constraints explicitly. France's framework illustrates this approach by establishing a bonus targeting hard-to-recycle resins in sensitive-contact packaging, structured with a transitional rate of 550 EUR per ton for 2026-2027 before scaling up to 1,000 EUR per ton, providing the long-term runway to support the transition away from virgin resins.[9] This tiered structure, with the highest incentive for the hardest materials and a predetermined escalation, reflects the logic of calibrating fee differentials to the actual recycling economics by application.[10]

[7] Guide to Eco-Modulation: Technical and Economic Model for the Eco-modulation of Prices. *Ecoembes*.2026.
[8] See the Association of Plastic Recyclers' Plastics Recycling Glossary for additional details.
[9] Household Packaging Rate Guide. CITEO. 2026. P. 51.
[10] Household Packaging Rate Guide. CITEO. 2026. P. 51.

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COMPLEMENTARY CONDITIONS FOR ECO-MODULATION TO EFFECTIVELY SUPPORT PCR MARKETS

Eco-modulation functions best not as a standalone solution but as part of a policy environment that creates stable demand, protects feedstock quality, and supports infrastructure. The following conditions, addressing the lessons above, work together to create a system with the potential to drive PCR market development.

- **Mandatory PCR content floors:** Mandates can create stable baseline demand, while eco-modulation provides an economic signal to increase PCR content use. Where PCR content use remains voluntary, bonuses must be sufficiently meaningful and predictable to influence material procurement decisions.
- **Recyclability criteria aligned with national design-for-recyclability (D4R) standards:** Standards such as the APR Design Guidelines support future feedstock quality. In the U.S. context, Circular Action Alliance's (CAA) Responsible End Market program provides a certification framework that verifies recycled material flows to responsible end markets meeting defined yield and quality requirements, as an example of the kind of operational infrastructure that eco-modulation frameworks can build on.
  Recognizing that end markets are needed now, while higher-quality feedstock is critical for long-term system health, tiered eco-modulation schedules can support both short-term and longer-term policy priorities. Bonuses should reward circular PCR content use as the primary incentive tier, while providing a defined secondary pathway for applications where PCR content use demonstrably supports domestic reclaimer economics and incentivizes continued investment in the system. This secondary tier could encompass two categories: packaging formats where infrastructure gaps rather than design choices are the barrier to recyclability, and durable applications (such as carpeting and decking) where PCR use sustains reclaimer demand and processing economics during an infrastructure development period. In both cases, secondary pathways should be clearly defined and periodically reevaluated.[11]
  Where applicable law recognizes non-mechanical recycling pathways, eligibility for PCR-related incentives should depend on transparent and verifiable performance criteria. France's CITEO framework illustrates one approach: processes where mass yield is below 50% are excluded from PCR incentive eligibility[12], establishing a performance floor that applies regardless of the recycling method used. Additional criteria worth considering include chain-of-custody, environmental performance, and responsible end market requirements.

[11] Secondary pathways should be clearly defined, evidence-based, time-limited, and periodically reevaluated as recycling infrastructure and markets develop. Flexible film PCR incorporated in to stretch or shrink film is an example: film-to-film PCR use supports reclaimer economics even though stretch and shrink film are not currently considered recyclable in most U.S. markets.
[12] Household Packaging Rate Guide. CITEO. 2026. P. 51.

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- **Supporting Recycling Infrastructure and PCR Supply:** Eco-modulation can increase demand for PCR content, but demand-side incentives must be supported by sufficient collection, sorting, and reprocessing capacity to generate reliable supplies of quality PCR feedstock. EPR program investments in collective systems, MRF upgrades, advanced sortation, and reprocessing capacity (including direct subsidies to MRFs and reclaimers for specific material streams where processing economics are not yet viable at commercial scale) can complement eco-modulation by addressing supply-side constraints and expanding the availability of recycled feedstock.
- **Complementary policy levers:** Eco-modulation is one component of a broader policy framework for strengthening PCR markets. Complementary policies can address conditions that producer fee incentives alone cannot. For example, deposit return systems (DRS) can increase the quality and quantity of PET and other beverage-container feedstock; long-term reclaimer contracting mechanisms can provide greater certainty for reclaimers and producers; and appropriately designed incentives can support investment in domestic recycling and PCR capacity. Federal and state tax incentives, such as credits for investment in domestic recycling infrastructure or PCR processing capacity, can also serve as complementary levers that offset the upfront capital costs of packaging design and infrastructure development, compounding the financial signal created by eco-modulation.

CONCLUSION

Eco-modulation can strengthen PCR markets, but only when its incentives are compelling enough to change behavior, tied to consistent recyclability criteria, and differentiated by material and application. Because it is unlikely to deliver outcomes that are not required elsewhere, it works best alongside PCR content requirements, recyclability standards, infrastructure investment, and complementary levers such as deposit return systems and tax incentives. As more U.S. EPR programs finalize their fee structures and outcome data becomes available from the 2026 European changes, applying these lessons can help ensure that eco-modulation rewards the design choices and PCR use that build a durable domestic market.

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