

Unclassified

English - Or. English

9 June 2021

ENVIRONMENT DIRECTORATE
ENVIRONMENT POLICY COMMITTEE

Working Party on Resource Productivity and Waste

Modulated fees for extended producer responsibility schemes (EPR)

Contact persons:

Andrew Brown (Andrew.Brown@oecd.org);

Frithjof Laubinger (Frithjof.Laubinger@oecd.org);

Peter Börkey (Peter.Borkey@oecd.org);

Maarten Dubois (Maarten.Dubois@oecd.org)

JT03477959

Table of contents

List of abbreviations and acronyms	4
Executive summary	5
1. Introduction	7
2. EPR fee structures	8
2.1. “Basic” EPR fee modulation	9
2.2. “Advanced” EPR fee modulation	10
2.3. Policy intervention to implement advanced fee modulation	11
3. Criteria for advanced fee modulation and initial results	13
3.1. Criteria and existing cases	14
3.2. Initial results of bonus/malus systems	19
4. Key issues in EPR fee modulation	21
4.1. Cost recovery	21
4.2. Magnitude of modulation	22
4.3. Competition	23
4.4. Harmonisation	23
4.5. Complexity and administration	24
4.6. Design trade-offs	24
4.7. Free-riding and enforcement	25
4.8. Governance	26
5. Advanced fee modulation in the context of a policy mix	28
5.1. Regulations	29
5.2. Product standards and recycled content requirements	30
5.3. Market based instruments	30
5.4. Green public procurement (GPP)	31
5.5. Indicators and performance evaluation	31
5.6. Research and development	32
5.7. Information instruments	32
6. Key policy insights	34
References	35

Tables

Table 1. Overview of fee modulation types	9
Table 2. Food packaging trends in Europe	10
Table 3. Overview of advanced criteria	13
Table 4. Examples of EPR fee modulation for packaging according to recyclability criteria	15
Table 5. Example of EPR fee modulation according to presence of hazardous substances	16
Table 6. Example of EPR fee modulation according to providing information	16
Table 7. Examples of EPR fee modulation according to recycled content criteria	17
Table 8. Examples of EPR fee modulation according to durability, reparability, reusability, or waste prevention criteria	18
Table 9. Results of initial implementation	19
Table 10. Key Issues in EPR fee Modulation	21
Table 11. 2020 PRO fees of the Belgian PRO for consumer electronics Recupel	23
Table 12. Complementary measures to instigate DfE	29
Table 13. Regulatory instruments	29
Table 14. Advanced fee modulation in the context of policy alternatives	31

Figures

Figure 1. EPR by product type, worldwide	8
--	---

Boxes

Box 1. European Commission guidance on EPR fee modulation	10
Box 2. Product durability and fee modulation	22
Box 3. EPR in light of the digital transformation	24
Box 4. EPR governance of Fee Modulation	26
Box 5. Different approaches to brominated flame retardants (BFRs) and Recycling Inhibitors in different OECD countries	28
Box 6. Signalling function of EPR fees	32

List of abbreviations and acronyms

BPA	-	Bisphenol A
CPR	-	Collective Producer Responsibility
CBA	-	Cost-benefit analysis
DRS	-	Deposit Refund System
DfE	-	Design for Environment
EEE	-	Electrical & Electronic Equipment
ELV	-	End-of-life vehicle
EOL	-	End-of-life
EPR	-	Extended Producer Responsibility scheme
IPR	-	Individual Producer Responsibility
PRO	-	Producer organisation
PRN	-	Packaging Recovery Notes
REACH	-	Registration, Evaluation, Authorization and Restriction of Chemicals
RoHS	-	Restriction of Hazardous Substances
SMEs	-	Small and Medium sized Enterprises
WEEE	-	Waste Electrical & Electronic Equipment
WFD	-	Waste Framework Directive

Executive summary

Extended Producer Responsibility (EPR) is an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of the product's lifecycle. Producers can individually or collectively fulfil their EPR obligations. In individual producer responsibility (IPR) systems, producers take responsibility for their own products, whereas in collective producer responsibility systems (CPR) producers of the same product type collaborate and pay an EPR fee to a Producer Responsibility Organisation (PRO). EPR fee modulation is the modification of fees paid by producers in a CPR scheme based on measurable product characteristics.

Whilst IPR systems better incorporate the "polluter pays principle" and provide stronger incentives for individual producers to reduce product waste, collective schemes are to date more common as they are generally considered more cost-effective. The proliferation of CPRs has coincided with increases in recycling rates and financial support for waste management services, however there is little evidence to suggest that collective EPR has instigated Design for Environment (DfE) as initially anticipated.

The sophistication of fee modulation varies. *Basic* fee modulation applies rather simple averages per material (weight) or product type, based on measurable end-of-life (EoL) cost differences. *Advanced* fee modulation increases the specificity of producer fees through a more granular EoL cost allocation (higher and lower fees) or a system of bonus/malus adjustments. The greater specificity provided by advanced EPR fee modulation theoretically strengthens the incentives for DfE.

The criteria used to modulate EPR fees determine the impacts at different stages of the lifecycle. Criteria on recyclability, recycling rates and the presence of hazardous substances can instigate eco-design changes that reduce the EoL costs of a product. Criteria aimed at increasing a product's lifespan or encouraging the use of secondary raw materials also instigate DfE, but the benefits are not limited to the EoL stage.

A number of countries have started to modulate EPR fees along these criteria, but due to the fact that these policies are very recent, the insights about the performance of these schemes are limited. Initial results from the French EPR scheme for packaging show that the share of products receiving a malus penalty decreased over time.

Whilst advanced fee modulation can provide a direct economic incentive for DfE, its implementation requires the consideration of a number of issues:

- Advanced fee modulation adds complexity to EPR systems and therefore increases the administrative load of all stakeholders. Additional costs arise, both initially (e.g. to establish the modulation system) and on an ongoing basis (e.g. costs of additional reporting, monitoring and enforcing). Additional complexity can also lead to increased free-riding when firms find it too difficult or costly to comply. These costs of advanced fee modulation should be considered relative to the added benefits.
- Advanced fee modulation needs to be designed in a way that it does not jeopardise full cost recovery and the financial stability of the EPR systems where it is applied. For example in a bonus-malus system, additional revenues from malus fees and reduced revenues from bonus fees need to be balanced out at the level of the PRO.
- The amplitude of fee modulation requires careful consideration. A small ratio of fee modulation to product price will provide little incentive for DfE. A further fee adjustment, however, where fees are no longer linked to the costs that a particular product design induces at the end-of-life stage, can lead to a sense of arbitrariness or loss of transparency, as well as diverging from the polluter pays principle.

- A lack of harmonisation of fee modulation criteria across jurisdictions could lead to hampering the effectiveness of the approach, by resulting in mixed signals, increased compliance costs, and insufficient incentives to producers for DfE. This is particularly true for durable goods (goods with a long use-phase, such as electrical and electronic equipment) that are often designed for the global market, such as electric and electronic equipment.

Some of these issues, as well as the underlying collective action problems can justify intervention by policy makers to ensure a proper incentive structure that instigates DfE.

A few EPR systems have started to apply advanced fee modulation, for example in France, Italy, and in North America at the sub-national level. Despite the limited experience, several policy insights and good practices can already be put forward:

- EPR systems need clear objectives, periodic reviews and evaluations. Long-term objectives ensure predictability and reduce uncertainty about short-term changes. Periodic reviews and evaluations improve the effectiveness and relevance of fee modulation.
- Stakeholder networks in EPR systems can be instrumental in collecting insights on the feasibility and likely effectiveness of the criteria that could be used to modulate EPR fees, as well as coordination between producers and recyclers.
- The experience of early adopters of advanced EPR fee modulation can inform subsequent policy efforts.
- For ensuring clear incentives for producers, it is important that the criteria used to modulate EPR fees be:
 - Easily understandable, auditable, and enforced; and
 - Harmonised within federal and semi-federal systems, and coordinated at a wider geographical scale where possible.
- Non-durable products (goods with a short use phase, such as packaging) exhibit a higher fee to product price ratio and are more often designed for specific markets than durable products. As such, these may lend themselves better to advanced fee modulation.
- Fee modulation is one tool within a larger policy context to stimulate DfE. It can be complemented with other policy tools, such as:
 - Recycled content requirements to provide a strong *demand pull* for high-quality recycled material;
 - Green Public Procurement to strengthen demand of eco-friendly products;
 - Market based instruments to address externalities throughout the lifecycle and create incentives for DfE accordingly; and
 - Bans and product requirements to ensure minimum product standards and protect environmental and human health from significant hazards.
- Additional complexity of advanced fee modulation requires cost-effective data collection and management capacity. This may be more easily available in mature EPR systems. It is therefore advisable to begin with basic fee modulation when a new EPR is established, so as to minimise complexity of initial implementation.

1. Introduction

Extended Producer Responsibility (EPR) is an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of the product's lifecycle. The approach was developed in response to mounting issues for the public sector to manage and recycle the increasing volume and complexity of waste in the last decades of the twentieth century (OECD, 2016^[1]).

OECD (2016^[1]) puts forward several main objectives for EPR. First, shift the financial responsibility of waste management from municipalities to producers. Second, by implementing the “producer pays principle”, give an incentive to producers to invest in Design for Environment (DfE), also commonly referred to as eco-design (Lindhqvist, 2000^[2]). In addition, EPR policies often contain targets or incentives that aim to increase recycling rates.

EPR schemes have been proven effective as a means to shift some waste management costs from tax payers to the producers and consumers of the waste generating products (OECD, 2016^[1]). As well, implementation of EPR schemes has induced increased recycling rates and reduced final disposal of covered materials. However, there is as of yet limited evidence that EPR schemes have triggered DfE (OECD, 2016^[1]). One explanation for the weak eco-design performance is a misalignment of the costs of product design and the costs borne by producers in EPR schemes.

Producers can fulfil their EPR responsibilities individually or collectively. In individual producer responsibility (IPR), producers take responsibility for their own products. Since all waste management costs and potential savings from design choices are internalised, incentives are individualised.

In collective producer responsibility systems (CPR) producers of the same product type collaborate via a Producer Responsibility Organisation (PRO) that is mandated to manage the product waste stream, report to central authorities, and ensure clear communication to consumers and producers. The producers pay a contribution (an EPR fee) to the PRO to cover the costs. Importantly, the granularity to which PROs allocate the end-of-life management costs of individual products to specific firms within a CPR system varies and is often limited with respect to instigating DfE.

Whilst IPR schemes provide stronger incentives for individual producers to reduce product waste, CPR schemes are generally considered more cost-effective. As a result, almost all EPR schemes are organised collectively owing to economies of scale and administrative ease (OECD, 2016^[1]).

EPR fee modulation is the modification of fees paid by producers in a CPR scheme based on measurable product characteristics. Modulation thus determines the cost distribution between covered producers and the granularity of internalisation of end-of-life costs by firms. More modulation shifts the economic responsibility of producers in CPR systems closer to IPR, which, in theory, strengthens economic incentives for DfE.

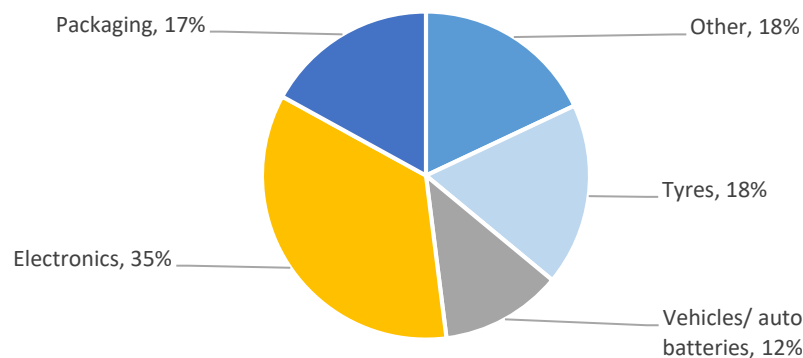
Whilst modulating EPR fees along more specific criteria is receiving increasing policy attention as a means to strengthen DfE incentives, there are concerns about increased administrative complexity and secondary effects. Moreover, fee modulation alone is unlikely to be sufficient to instigate an optimal investment in eco-design and will need to be a component in a larger coherent policy mix.

This paper provides a discussion of fee modulation in EPR. Insights are based on an extensive literature review, as well as expert consultations with different stakeholders. The paper is structured as follows: Chapter 2 outlines the different approaches to fee modulation and Chapter 3 takes stock of existing EPR schemes with modulated fees. Chapter 4 discusses key issues and considerations for implementing modulated EPR fees, whilst Chapter 5 puts modulated EPRs in the context of a broader policy framework. Finally, Chapter 6 concludes with policy insights.

2. EPR fee structures

In the last three decades, the principle of EPR has been increasingly implemented in waste policy (OECD, 2001^[3]). Now, more than 400 schemes are in place worldwide, up from about 30 in 1990 (OECD, 2016^[11]). EPR schemes have been implemented in a diverse set of product types, including electronics, vehicles, batteries, tyres, and packaging (Figure 1).

Figure 1. EPR by product type, worldwide



Source: (OECD, 2016^[11]).

In collective EPR schemes, PROs must have criteria and a method of setting fees to determine the amount to be paid by each producer to recover costs. The sophistication of fee modulation varies depending on the underlying methodology and the phases of the lifecycle targeted.

There are two possible methodologies:

- A more granular allocation of measurable operational costs of PROs, varying from an average cost per material or product to an almost exact representation of EoL costs that allocates a higher or lower fee depending on design criteria; or
- Incentives based on bonus and/or malus fee adjustments. These can, but do not need to reflect measurable operation cost differences of EoL products. Instead, the magnitude can also be increased to strengthen design change incentives.

Furthermore, fee modulation can incentivise action at different phases of the product lifecycle. Commonly, EPR fees incorporate the EoL cost (i.e. cost of collection, sorting and treatment/recycling) of a product and fee modulation is intended to incentivise DfE to reduce EoL costs. But, depending on the criteria chosen, modulated fees can also target environmental impacts occurring at other stages of a product's lifecycle; for example, incentivising the use of secondary materials.

Table 1 depicts the distinction between different “arch-types” of *basic* and *advanced* fee modulation. Basic fee modulation applies rather simple averages per material (weight) or product type, based on measurable EoL cost differences. Advanced fee modulation is defined as any fee modulation on more detailed criteria (e.g. recyclability).

Further distinction exists along the methodology (granular allocation of EoL costs or bonus/malus modulation). Advanced fee modulation with bonus/malus methodology, can target the EoL stage and/or

other stages of the lifecycle. Granular cost allocation, on the other hand, is by its nature only targeting the EoL stage of a product's lifecycle.

Table 1. Overview of fee modulation types

Level of Modulation	Methodology	Lifecycle Stage	Modulation Type	Criteria examples	Issues or Considerations
Basic	Granularity (Allocation of approximated EoL costs)	End of Life (EoL is the focus)	"Basic"	Product Type, Weight, Source (post-consumer and post-industrial) used as a proxy for EoL costs	<ul style="list-style-type: none"> Costs of design choices are not internalised by each producer; Incentive to lightweight, even at expense of recyclability
					<ul style="list-style-type: none"> Additional complexity Determining of exact EoL costs can be challenging Potentially limited incentives for design change by producers
Advanced	Granularity (Allocation of actual EoL costs, where possible)	End of Life	"Advanced EoL with Granularity"	Recyclability, Recycling Rate, Presence of Hazardous Substances, Consumer Awareness	<ul style="list-style-type: none"> Arbitrariness: in some cases, fee adjustment is not tied to actual cost differences of the design change; Additional complexity
					<ul style="list-style-type: none"> Arbitrariness: in some cases, fee adjustment is not tied to actual cost differences of the design change; Additional complexity
Advanced	Bonus/Malus (Bonus/malus adjustments to basic fee)	End of Life	"Advanced EoL with Bonus/Malus"	Recyclability, Recycling Rate, Presence of Hazardous Substances, Consumer Awareness	<ul style="list-style-type: none"> Arbitrariness: in some cases, fee adjustment is not tied to actual cost differences of the design change; Additional complexity
					<ul style="list-style-type: none"> Arbitrariness: in some cases, fee adjustment is not tied to actual cost differences of the design change; Additional complexity
Advanced	Bonus/Malus (Bonus/malus adjustments to basic fee)	Lifecycle (Aspects of all lifecycle stages, beyond EoL, can determine fee modulation)	"Advanced Lifecycle with Bonus/Malus"	Recycled Content, Product Lifespan	<ul style="list-style-type: none"> Arbitrariness: in some cases, fee adjustment is not tied to actual cost differences of the design change; Additional complexity
					<ul style="list-style-type: none"> Arbitrariness: in some cases, fee adjustment is not tied to actual cost differences of the design change; Additional complexity

Source: Authors.

2.1. "Basic" EPR fee modulation

Most collective EPR schemes to date use fee modulation of *basic* criteria that is largely based on unit, weight and/or material, representing, in a rough way, the cost associated with managing the end-of-life product. For example, under basic fee modulation, 1 mobile phone = 1 unit so all mobile phones have the same EPR fee regardless of other design aspects. The EPR fee for packaging typically depends on the weight of the compound (glass, paper, metal, etc.) regardless of other design elements of the product that may impact the EoL cost or other stages of the lifecycle (such as design for recyclability, reparability or the use of secondary materials).

Basic fee modulation aims to cover the operational cost for collection and treatment of the end-of-life product as well as the costs for communication, reporting and other legal requirements. The magnitude of EPR fees differs between products and countries due to differences in operational costs for waste management between materials, markets and collection systems.

In concert with other policy measures, weight-based fee charging incentivises design of lighter products ("lightweighting") and has contributed to weight reductions of packaging for most materials over the past decades (Table 2).

Table 2. Food packaging trends in Europe

Packaging & product	Average weight (kg)		% change
	Year 2000	Year 2010	
PET bottle of 1,5 L still water	0,0318	0,0280	-12%
Aluminium can of 330 ml for soft drinks	0,0158	0,0131	-17%
Glass bottle of 250 ml for olive oil	0,2236	0,2002	-10%
Tin can of 125 gr for fish	0,0343	0,0319	-7%
Plastic bag for 1 kg of pasta	0,00903	0,00785	-13%
Cardboard box for dry food	0,01388	0,01132	-18%

Source: (Pro Europe 4 Prevention, 2018^[4]).

Some EPR systems (e.g. packaging in Austria and Netherlands) differentiate their fees for household and commercial/industrial waste. The rationale is straightforward since it costs less to collect and sort commercial packaging waste than household waste.

2.2. “Advanced” EPR fee modulation

Modulating fees according to a more diverse, *advanced* set of criteria can provide for more targeted incentives for design. Fee modulations that give a bonus or a malus based on criteria such as recyclability or reusability may reflect the end-of-life or environmental costs¹ of products more appropriately.

As part of its circular economy package, the European Commission is endorsing advanced modulation of fees in several waste streams, including packaging, electronics and batteries. In May 2018, an amendment to the EU Waste Framework Directive (WFD) (2018/851) put forward modulated EPR fees according to criteria for durability, reparability, reusability, recyclability and presence of hazardous substances (EU Lex, 2018^[5]). The European Commission is currently developing technical guidance to guide and support the implementation by its Member States (see Box 1).

Box 1. European Commission guidance on EPR fee modulation

The amended EU Waste Framework Directive states that “Member States shall take the necessary measures to ensure that the financial contributions paid by the producer of the product to comply with its extended producer responsibility obligations in the case of collective fulfilment of extended producer responsibility obligations are modulated, where possible, for individual products or groups of similar products, notably by taking into account their durability, reparability, re-usability and recyclability and the presence of hazardous substances, thereby taking a life-cycle approach and aligned with the requirements set by relevant Union law, and where available, based on harmonised criteria in order to ensure a smooth functioning of the internal market” (Article 8a 4(b), European Parliament, 2018).

In order to assure a certain degree of cross-country harmonisation in the adoption of EPR fee modulation, Article 8-5 of the same Directive requires the European Commission to publish related guidelines in consultation with Member States. The European Commission is currently developing technical guidance in this respect.

¹ These include all environmental costs occurring over the lifecycle of a product.

The study to support preparation of the Commission's guidance, developed by consultancy Eunomia, presents current and planned EPR fee modulation practices in different sectors (Hogg et al., 2020^[6]). It discusses the rationale for granular EPR fees and proposes modulation criteria in different sectors:

- *Packaging*: recyclability, recycling rate, reusability, recycled content.
- *Electronics*: disassembly and repair, cost of spare parts, durability and warranty period, recycled content, presence of hazardous substances.
- *Batteries*: rechargeability, recycled content, charge capacity and battery lifetime, collection rate, recycling rate and recyclability.

The principal benefit of fee modulation based on advanced criteria is a more granular cost distribution among firms that provides producers with additional incentives to invest in DfE. The benefit for society is twofold:

- Lower costs of EPR implementation in the long term (if advanced fee modulation instigates design changes for improved recyclability). These cost savings will be reflected in lower costs to PROs and firms, either benefitting the firms themselves or lowering prices for consumer; and
- Lower environmental impacts of products beyond EoL costs (if advanced fee modulation instigates design changes to e.g. increase recycled content in the product material mix).

A key benefit of advanced modulation can be the *signalling function*. If disclosed, a “bonus” allows consumers and procurement departments from companies or governments to identify environmentally preferable products. Conversely, a “malus” helps to identify products with larger environmental impacts. Government can for instance include such criteria in their green public procurement strategies and ecolabels that draw on bonus/malus criteria can aid consumers to make more informed purchasing decisions, both driving the demand and consumption of more sustainable products.

Furthermore, CPR schemes connect producers and recyclers in a formal structure via the PRO. This *interactive platform* enables knowledge transfer between different stakeholders along the value chains about e.g. optimal product designs, recycling opportunities and barriers. This platform can be leveraged to identify and take stock of key issues as well as opportunities and can result in voluntary design improvements.

2.3. Policy intervention to implement advanced fee modulation

There are a number of reasons why stakeholders in CPR schemes would opt for basic fee modulation:

- Producers and PROs can perceive that there is a net cost to implementation; the benefits of a more advanced fee modulation system (e.g. lower recycling costs) do not justify the costs incurred by the added complexity of implementing and complying with such a system.
- Collective action problems may occur:
 - CPR schemes search for an industry-wide consensus. In contrast, advanced modulation gives bonuses to front runners and malus charges to laggards. Consequently, PROs are inclined to use basic modulation to avoid internal conflicts.
 - Where several PROs compete and there is a common perception that there is a net cost to implementation of advanced fee modulation, there is little incentive for one of the PROs to establish such a system due to the additional costs (at least in the short-term) and the pressure to remain cost-competitive.
- For “Advanced lifecycle modulation”, the benefits of DfE are (at least partially) external to PRO responsibilities and operation costs, suggesting insufficient incentive to take action. For example,

incentives to increase the recycled content of products do not necessarily reduce EoL costs for PROs.

Policy interventions can facilitate the integration of advanced fee modulation in EPR regulation. For example, the ongoing update of the EU Waste Framework Directive serves to instigate EU Member States to develop legislation that requires PROs to implement advanced fee modulation (see Box 1).

3. Criteria for advanced fee modulation and initial results

Criteria for advanced fee modulation can target different impacts at different stages of the lifecycle and follow different modulation methodologies (Table 3). This chapter outlines the different criteria that can be applied, as well as existing case examples.²

It is important to note, some criteria that follow will be relevant for some but not all waste streams. For example, fee modulation for efforts to improve reparability is only applicable for durable goods, such as electrical and electronic equipment (EEE) or vehicles.

Advanced fee modulation that has relatively low implementation costs and high environmental gains (“low-hanging fruits”) will be a good starting point for policy action. Several stakeholder groups suggested that modulating fees for non-durable products with recyclability criteria has a strong benefit to cost ratio, considering current national developments, industry efforts and platforms already in place (Expra, 2018^[7]).

Table 3. Overview of advanced criteria

Advanced Criteria	Description	Applicable Waste Sector	Issues or Considerations	Example(s) ³
Advanced EoL Fee Modulation				
Recyclability	Specifications for product characteristics that determine recyclability	Packaging, EEE, Batteries, Vehicles	<ul style="list-style-type: none"> Recyclability can be location or market specific due to cost feasibility Could inhibit innovation and instead promote current recycling technologies 	Packaging schemes in Belgium, the Netherlands, Italy, France, Portugal, and Sweden.
Recycling Rate	Ratio of material that is actually recycled from total waste generated	Packaging, EEE, Batteries, Vehicles	<ul style="list-style-type: none"> Costly to implement, highly disaggregated data will be needed Depends on collection, which is typically beyond the producer's design choice 	
Presence of Hazardous Substances	Presence or absence of substances that inhibit circularity	Packaging, EEE	Regulation may be more appropriate	EEE scheme in France Packaging and graphic papers, France
Consumer Awareness	Actions or labels that improve consumer behaviour, such as sorting	All	Limited evidence of connection to EoL costs and could instead be imposed by regulation	Packaging in France
Advanced Lifecycle Fee Modulation				
Recycled Content	Ratio of recycled content in the product	Packaging, EEE, Batteries, Vehicles	Potential trade off with recyclability	Packaging schemes in Germany, France, Canada (Quebec); Carpets in U.S. (California); Textiles and Shoes in France; Cardboard and Graphic Paper in France
Product Lifespan	Specifications for durability, reparability, reusability, or waste prevention of product	Durable goods such as EEE	<ul style="list-style-type: none"> Little connection to end of life costs Potential trade off with other product characteristics like recyclability 	EEE and Batteries in France; Packaging in France; Packaging in Italy; Packaging in Estonia; Industrial Packaging in Belgium; Tyres in Portugal

² Chapter 5 discusses the suitability of fee modulation criteria in the context of policy alternatives and complements.

³ Examples are not an exhaustive list. For a more extensive list of PROs with advanced criteria, see individual criterion example tables in Section 3.1.

3.1. Criteria and existing cases

3.1.1. Recyclability

Fees can be differentiated according to the degree of recyclability of a product. Generally, criteria should refer to specific, identifiable product features that are known to complicate the existing recycling scheme, such as product format, material, size, colour and transparency or the presence of disruptors such as specific inks, adhesives and labels.

A distinction can be made between technical recyclability (i.e. whether a product is recyclable given existing state-of-the-art technologies) and practical recyclability under specific market conditions (e.g. whether a product is recyclable in a certain country, given its specific recycling and waste management infrastructure). Differences in markets and the dispersion of waste management capital in different locations can lead to competing definitions of specific criteria for practical recycling.

The extent of recycling capabilities is not fixed, but dynamic. EPR fee modulations according to recyclability criteria could also inhibit innovation and instead promote designs that are recyclable under current recycling technologies.

Criteria should thus seek to provide incentives for innovation and not simply conformity to today's best practices. The Italian EPR system addresses this by distinguishing recyclability based on the maturity of technologies to incentivise those technologies that are in the process of consolidation and development.⁴

Indirectly, some of these recyclability criteria have already led to fee modulations in the more conventional activity-based costing, where each material is priced with its average respective end-of-life management cost. Products that complicate collection, sorting and recycling have higher operational costs which generally induce higher EPR fees. However, the granularity of activity-based costing differs among EPR schemes.

Some examples of EPR fee modulation in OECD countries that include sortability and recyclability criteria are presented in Table 4.

⁴ As the maturity of technologies and thus the sortability and recyclability of different packaging evolves over time, these developments are monitored and updated periodically. CONAI established a specific Permanent Technical Assessment Committee, which with the support of industry experts proposes to the Board possible changes to the category lists. This technical committee consists of four CONAI directors: two packaging producer representatives and two user representatives (CONAI, 2020_[61]).

Table 4. Examples of EPR fee modulation for packaging according to recyclability criteria

Country (PRO)	Examples of recyclability criteria
Belgium (Fostplus)	The EPR fee for transparent PET (EUR 200/t) is less than half the price of coloured PET (EUR 470/t). Higher fees apply for rigid packaging and plastic films (a.o.) (Fostplus, 2020 ^[8]).
France (CITEO)	CITEO's 2020 fee criteria applies penalties for packaging based on a three tier system (penalties also cancel qualifications for bonus for awareness raising): <ul style="list-style-type: none"> • Rates (by material) decreasing based on the maturity of recycling facilities (three classifications: no recycling channel; facilities in the process of development; well established channel), • 10% increase to harder to recycle items such as glass with non-magnetic cap, some plastics (e.g. with carbon black, PE with PP above a density threshold, and PET with glass beads), and cardboard with mineral oil ink, • 50% increase for some mixed-material packaging compared to mono-material products (reinforced cardboard and PET combined with aluminium, PVC, or silicone) and glass (except lime soda bottles without infuse element), • 100% increase for non-recyclable material (per national guidelines) and opaque PET with >4% mineral filler. (CITEO, 2019^[9]).
The Netherlands (Afvalfonds Verpakkingen)	Plastic packaging that is recyclable and has a positive market value upon sale to the recycler is given a bonus, in order to reflect the cost savings. Recyclability is supported by the 'Recycle Check' from the Netherlands Institute for Sustainable Packaging (KIDV) and is updated annually (Afvalfonds Verpakkingen, 2018 ^[10]).
Italy (Conai)	Three differentiated groups based on sortability and recyclability (to date this applies to plastics packaging, eco-modulation for paper is under development) (fees for 2020): <ul style="list-style-type: none"> • Packaging with an effective and consolidated industrial sorting and recycling chain, mainly from the commerce and industry (C&I) circuit (LEVEL A): 150 EUR/t • Packaging with an effective and consolidated sorting and recycling chain, mainly from the household circuit (LEVEL B1): 208 EUR/t • Packaging from household and C&I circuit with an industrial sorting and recycling chain in the process of consolidation and development (LEVEL B2): 436 EUR/t • Packaging with experimental sorting/recycling activities in progress or not sortable/recyclable with current technologies (LEVEL C): 546 EUR/t (CONAI, 2020^[11]).
Portugal	A 10% penalty is applied to: PET bottles with PVC label or metal cap, and glass bottle with stopper made of ceramic or steel (Hogg et al., 2020 ^[6]).
Sweden	Packaging is split between a high and a low fee, determined by material and product type, colouring and surface print, and presence of a sleeve (Förpacknings och Tidnings Insamlingen, n.d. ^[12]).
Chile	Collective management systems for packaging must modulate fees with bonus or malus based on complexities for collection and recycling (Ministerio del Medio Ambiente Chile, 2021 ^[13]).

3.1.2. Recycling rate

EPR fees can also be modulated according to the share of waste that is actually recycled. Concretely, a bonus can be provided to waste categories, whose recycling rate is above average over a specific lapse of time, or vice versa a penalty for lower than average collection/recycling rates.

This approach, however, may require considerable implementation costs, as it requires disaggregated data and precise measurements in order to distinguish between the recycling rate of different types of packaging and materials. Recording granular waste collection data (based on e.g. plastic polymer type) may increase monitoring and reporting costs for producers, PROs and recyclers. Policymakers will likely need to define a recycling rate methodology and which processes will qualify as recycling.

Since municipalities and consumers are also decisive for the collection and recycling performance, producers are hesitant to endorse this criterion.

3.1.3. Presence of hazardous substances

The presence of hazardous substances can significantly increase the costs of recycling, lower the value of recycled material and cause substantial environmental damage in case of improper disposal. Fees can be modulated to incentivise the phase-out of hazardous substances (Table 5).

Whilst hazardous substance regulations have already been effective in banning unwanted substances (e.g. the EU RoHS list) and define minimum quality requirements for a number of product groups (e.g. content concentrations of heavy metals in packaging (EUR Lex, 1994^[14])), modulated EPR fees could reward designs that go beyond minimum requirements of regulations (e.g. in product groups where regulations do not impose a direct ban, but maximum contamination levels) (see section 5.1 for a discussion of regulations as a complement or alternative to EPR fee modulation).

Table 5. Example of EPR fee modulation according to presence of hazardous substances

Country	Example of presence of hazardous substance criteria
France	<ul style="list-style-type: none"> PROs established criteria for EEE with a malus fee adjustment for products (vacuum cleaners, computers, and game consoles) with brominated flame retardants (BFRs) (EY, 2018^[15]). CITEO: 10% penalty for cardboard-paper packaging with mineral oils. This is intended as a transition towards a ban planned on the same substances as of 2022 (CITEO, 2019^[9]).

3.1.4. Consumer awareness

The success of EPR schemes depends on the participation and sorting by consumers. Awareness campaigns about appropriate end-of-life disposal of products can greatly improve recycling rates. In most EPRs, there is an obligation to collectively engage in consumer awareness and the PRO usually holds campaigns (sometimes jointly with local authorities) that provide coherent messages across the country.

EPR fees could be modulated to incentivise producers to do additional efforts to communicate about sorting instructions. For example, the French EPR scheme for packaging rewards such activities (Table 6).⁵ Clearly, the modulation should incentivise communication that is consistent with the general messaging of the PRO and/or local authority to avoid confusion.

Table 6. Example of EPR fee modulation according to providing information

Country (PRO)	Example of information provision criteria
France (CITEO)	<p>Awareness is one of several criteria for bonus/malus in the French EPR for packaging (CITEO):</p> <p>The bonuses include:</p> <ul style="list-style-type: none"> Awareness bonuses on-pack, ranging from 5-8%; and Awareness bonuses off-pack (awareness adverts on TV, radio, displays, etc.) of 4%; <p>The penalties include:</p> <ul style="list-style-type: none"> 100% penalty for packaging included in national sorting instructions but without an existing recycling channel (CITEO, 2019^[9]).

⁵ CITEO is reviewing its system of bonus fee adjustments for awareness raising due to regulatory changes that require most packaging to be marked with sorting instructions from 2022 (Article L541-9-3). As well, two further updates to the French anti-waste law for circular economy (AGEC) will impact malus payments for on-pack marking that may lead to confusion of sorting rules (including the green dot). The order of 30 November 2020 and the appendix to the decree of 25 December 2020 require a 100% penalty be applied to targeted packaging as of April 2021, with exceptions provided until 2022 for products with a marking set in obligation by another EU Member state (CITEO, 2021^[63]).

3.1.5. Recycled content

Modulating EPR fees based on recycled content aims at further strengthening the demand for secondary materials and at fostering recycling efforts in the targeted material. In such schemes, products that verifiably meet thresholds for recycled content receive a bonus or lowered fee.

The likely effectiveness and applicability of this criterion for EPR is contested. Some stakeholders argue that the measure is a flexible means to increase demand for recycled material and to reward producers that innovate with circular design. However, other stakeholders argue that recycled content can give mixed signals with respect to other design priorities such as lightweighting (recycled materials sometimes need a higher weight for the same strength).

A number of examples of fee modulation based on recycled content in packaging products are reported (Table 7).

Table 7. Examples of EPR fee modulation according to recycled content criteria

Country (State/Province)	Examples of recycled content criteria
France	EPR fees for packaging include a: <ul style="list-style-type: none"> • 10% fee reduction for cardboard and graphic paper (in publications) with > 50% recycled content, • 5% fee increase for using primary fibres from forests without eco-management labels, • 50% fee reduction for textiles and shoes with 15% recycled fibres/materials (EY, 2016^[16]), • 50% fee reduction for PE and PP containing at least 50% recycled content (CITEO, 2019^[9]).
Germany	The 2019 Packaging Ordinance requires PROs to provide incentives for sustainable packaging design and to modulate EPR fees accordingly. PROs are required to design fees that include differentiating fees along criteria of among others recyclability (given existing technologies) and recycled content and content of renewable materials (BMJV Germany, 2019 ^[17]).
Canada (Quebec) ⁶	EPR fee modulation is applied to packaging, inspired by the French bonus/malus scheme system. This involves a 20% bonus for producers who entirely manufacture packaging with recycled content and who use at least 50% to 80% of recycled content for printed materials (e.g. magazines and other publications) (EEQ, 2020 ^[18]).
United States (California)	State law establishing EPR for carpets requires a difference in fees for the presence of post-consumer recycled content (California Legislative Information, 2020 ^[19]).
Chile	Collective management systems for packaging must modulate fees with bonus or malus based on recycled content, if the secondary material is derived from waste generated in Chile (Ministerio del Medio Ambiente Chile, 2021 ^[13]).

3.1.6. Product lifespan and waste prevention

Increasing the lifespan of products slows down the material throughput in the economy and avoids waste. Criteria that can increase the product lifespan include reusability, reparability or durability aspects:

- *Reusability criteria* can be useful to increase the lifespan of materials used in the packaging sector and shift from single-use packaging to refillable bottles and containers, where this is environmentally preferable. This can be incentivised by charging the EPR fee only upon a re-useable product's initial entry on the market. For consumer products, a deposit-refund system (DRS) may be a required complementary system to organise reverse logistics and reclaim reusable containers from consumers at the end-of-use.

⁶ In Canada, EPR is under the responsibility of provincial jurisdictions. EPR schemes with differing scope and responsibilities exist in all jurisdictions except Alberta. The involvement and degree of responsibility – both financial and managerial – of producers varies across EPR schemes in different provinces. For example, in British Columbia, producers have full responsibility for the management of packaging and printed paper; whereas in Manitoba, producers cover 80% of costs and municipalities cover the remainder of costs and operate recycling (EPR Canada, 2017^[60]).

- *Reparability criteria* can be useful in particular in the electronic and electrical equipment (EEE) product sector. Modulation criteria in this segment can refer to the ease of product disassembly and repair, the possibility to refurbish and upgrade products or a commitment to make spare parts available for a period of time.
- Modulating fees with *durability criteria* can provide incentives to steer product design towards more long-lasting and reliable products overall (see Section 4.6 on possible design trade-offs). Modulation criteria can, for instance, refer to the duration of product warranty periods.

The European Standardisation Organisations (CEN and CENELEC) developed standards on material efficiency for energy-related products. The set of standards includes standards on reparability (EN45554:2020) and durability (EN45552:2020) of energy-related products (CEN-CENELEC, 2020^[20]). These broader standards can serve to develop product-specific standards that help establish EPR modulation criteria for product lifespan considerations (see section 5.2 for discussion on product standards).

A number of countries have modulated fees along durability, reparability and reusability criteria. Most notably, the French EPR for consumer electronics, furniture and textiles includes a 20% bonus/malus fee based on various reparability and durability criteria (Table 8). CITEO also applies a bonus for weight reduction in packaging, whilst functionality is maintained.

Table 8. Examples of EPR fee modulation according to durability, reparability, reusability, or waste prevention criteria

Country (PRO)	Examples of durability, reparability, reusability or waste prevention criteria
Belgium (Valipac)	Reusable industrial packaging is exempted from EPR fees entirely.
Estonia	Reusable packaging does not need to be declared, if reused.
Portugal	Tyres placed on the market from the national retreading program are not charged an 'ecovalor' fee (VALORPNEU, 2018 ^[21]).
France	<p>20% fee <i>increase</i> for:</p> <ul style="list-style-type: none"> • Refrigerators, vacuum cleaners and drills without technical documentation for reparation – OR – unavailable spare parts. • Game consoles without technical documentation of reparation – OR – absence of spare parts – OR – presence of brominated flame retardants in the plastic hull. <p>20% fee <i>decrease</i> for:</p> <ul style="list-style-type: none"> • Washing machine or dish washer with spare parts available up to 11 years – OR – post-consumer recycled content > 10%. • Coffee machines and kettles with spare parts available up to 5 years – AND – availability of technical documentation for reparation. • Computers with standard peripherals including memory card and readers, absence of paints and covers that complicate recycling and reuse and recycled content of post-consumer plastics > 10%. • Printers that can be fully dismantled with standard equipment – AND – availability of spare parts for up to 5 years. • 'Eco-modulation': Lower rate for rechargeable batteries as compared with single use batteries (SCRELEC, 2019^[22]). • Eco-mobilier: scale-able furniture products are given a bonus modulation intended to reduce furniture waste. Supporting documentation examples include assembly instructions, such that duration of use can be extended (Eco-Mobilier, 2018^[23]). • ECO-TLC: a 75% bonus is given for clothing, home textiles, and footwear that meet durability requirements (ECO-TLC, 2019^[24]). <p>A one-time 8% bonus to producers that achieve weight reductions or that reduce the number of packaging units from the prior year, whilst maintaining ISO-material and functionality standards (CITEO, 2019^[9]).</p>
Italy (CONAI)	Reduced rates (up to 85% reduction) have been introduced for reusable packaging in controlled circuits.

3.2. Initial results of bonus/malus systems

Ex-post performance evaluations of advanced EPR fee modulation is limited, due to the recentness of the policy. PROs are still in the process of refining existing systems and producers are adjusting to the new incentives. Furthermore, to determine impact, a counterfactual is needed for comparability, as observed changes in markets may also be due to other trends. Nevertheless, in France, the number of products receiving a bonus or a penalty fee adjustment changed over the observed time period (see Table 9) (Joltreau, 2018_[25]). This early evidence can provide an indication on how industry responds to fee modulations in the different sectors.

Generally, the French EPR systems observe a response to the incentives and the share of firms and product units that qualify for a bonus increased over time, with some exceptions in EEE (washers and laptops). However, the evolution of the share of products that were liable to a penalty is mixed. For example, for several EEE products, the share of units penalised increased with time, whereas for packaging, the share reduced.

The observed differences between EEE and Packaging can be partially explained by the importance of the French market to the individual producer and the geographic reach of the product's design. In the packaging stream, a much larger change is observed in the units that received a bonus (+37.97%) compared to the share of members that received the bonus payments (+2.71%). Therefore, the bonus payments were dealt to members that have a larger than average presence in the French market (Joltreau, 2018_[25]). EEE producers are likely less incentivised to commit to design changes induced by EPR fee changes in only one jurisdiction as these products are usually produced for regional or global markets, have costlier design stages and generally a relatively smaller EPR fee to product price ratio.

Table 9. Results of initial implementation

Waste Stream	Country and PROs	Description of Initial Results
EEE	France: Ecologic, Eco- systems, Recylum, and PV Cycle	<p>Changes in the share of products receiving a penalty/bonus:</p> <ul style="list-style-type: none"> • Change in the share [percentage points] of products receiving a penalty: <ul style="list-style-type: none"> ○ Phase 1 (observed data from 2010-2012): laptops (+14); refrigerators (+5); phones (+3); vacuum cleaners (-2); TVs (-13). ○ Phase 2: cell phones (+12.5); vacuum cleaners (2.5); refrigerators (1.5); tablets (-6); game consoles (-0.63). • Change in the share [percentage points] of products receiving a bonus: <ul style="list-style-type: none"> ○ (Observed data from 2010-2016): lamps (+51); coffee/tea makers (+5.62); printers (+1.13); TVs (+9.38); washers (-3.5); laptops (-0.75).
Packaging	France: CITEO	<p>Change in the share of members [percentage points] receiving a penalty/bonus (2012-2015):</p> <ul style="list-style-type: none"> • Change in penalties: number of members (-49); packaging units (-4). • Change in bonus for awareness efforts: number of members (+2.71); packaging units (+37.97). <p>The share of PET bottles with presence of aluminium on the total deposit of clear PET bottles reduced from 2.3% in 2012 to 1.1% in 2015.</p> <p>The share of PVC bottles with malus on the share of total clear PET bottles reduced from 0.3% in 2012 to 0.1% in 2015 (Hogg et al., 2020_[6]).</p>
Graphic Papers	France: Ecofolio	<p>The share of units [percentage points] (observed data from 2013-2016):</p> <ul style="list-style-type: none"> • Units penalised decreased (-16), • Units that received a bonus increased (+14).
Textiles and Footwear	France: Eco-TLC	In 2017 approximately 0.27% of covered items received a bonus. Durability constituted ca. 96% of the bonus payments, 4% was for recycled content.
Furniture	France: Éco-Mobilier	In 2017, 2.5% of covered units received a bonus.

Source: Based on findings from (Joltreau, 2018_[25]) and (CONAI, 2018_[26]).

Notes: ECO-TLC introduced the bonus/malus system in 2012. The bonus/malus for furniture EPR was introduced in 2016.

French EPR schemes for textiles, footwear (Eco-TLC), and furniture (Éco-Mobilier) showed a very slow adoption by firms in the first years of advanced modulation. The proportion of product units that were eligible for bonus payments only reached 93,000 items out of the 2.5 million on the market (0.004%) for textiles and footwear products and 2.5% for furniture in 2017 (Joltreau, 2018^[25]). The low uptake may be due to insufficient incentives to instigate design changes, difficulties in certifying products, or too ambitious targets or criteria.

In Italy, since the introduction of a modulated EPR fee for packaging in 2019 there have been increased efforts to improve recyclability. Examples of DfE in plastics packaging by companies include:

- Replacement of sleeve labels with pre-drilled labels with instructions for separate collection.
- Two companies have switched from black-carbon-based dye (which are unrecognizable by optical readers) to organic pigments to ease sorting.
- A trial project for a dedicated recycling circuit of PET trays (CONAI, 2019^[27]).

An extra charge (20 €/t) on paper-dominated poly-packaging suitable for liquid containment has coincided with a 17% increase in dedicated recycling.

It is necessary to continue monitoring the performance and responses of firms to induced fee changes in order to get a better understanding of the effectiveness of criteria and fee magnitudes in the different product groups.

4. Key issues in EPR fee modulation

EPR fee modulation should be transparent, fair, and workable. It is likely that fee modulation entails a balance between fairness and workability. A system that better captures nuances in EoL cost differences and environmental impacts of design choices is more fair, but likely increases complexity and costs, as compared with a more streamlined, workable system. Advanced fee modulation thus needs to seek to instigate DfE while balancing fairness and workability. This chapter reviews several characteristics that are especially important to ensuring the tool's effectiveness: cost recovery, magnitude of the fees, competition, harmonisation of criteria, complexity, design trade-offs, free-riding, and governance. (Table 10).

Table 10. Key Issues in EPR fee Modulation

Issue	Description	Consideration
Cost recovery	PROs need to fully cover the cost of operations with collected fees.	Tie malus fee increases to bonus fee reduction payments. Fixed malus fee with flexible bonus (or vice versa) to maintain a net-zero change to the cash flow.
Magnitude of modulation	A small ratio of fee to product price will provide little incentive for DfE.	Increase the magnitude of fee modulation for products that have a small EPR fee to product price ratio.
Competition	Advanced fee modulation gives opportunity for capture to increase barriers to entry and decrease competition in markets.	Modulation should be based on objective and observable product characteristics. Modulation has to be transparent and compatible with national and international good practices.
Harmonisation	Differences in fee modulation between EPR schemes within or across jurisdictions can lead to mixed signals and insufficient incentives to producers for DfE, as well as increased compliance costs.	Central authorities can set criteria for modulation within a jurisdiction and work with other jurisdictions to coordinate criteria.
Complexity and administration	Additional costs arise through advanced fee modulation, both initially (e.g. to establish the modulation system) and ongoing (e.g. costs of additional reporting and monitoring).	Good governance structures can help to clarify processes, allow for stakeholder input and help contain the added complexity.
Design Trade-offs	Producers' pursuit of DfE to limit fee liability may result in unintended consequences of product characteristics.	Fee criteria should be considered within a coherent policy mix to ensure circular incentives throughout the lifecycle are internalised at the design stage.
Free-riding and enforcement	Additional complexity can lead to free-riding from firms that are unaware or select not to comply with EPR obligations.	Awareness campaigns and enforcement is needed in product streams with significant free-riding. Criteria need to be made simple, verifiable and enforceable.
Governance	Complexity of fee modulation requires additional decisions to be made in EPR governance.	Set clear objectives, roles and responsibilities, and decision making processes.

Source: Authors.

4.1. Cost recovery

Fee modulation schemes should be designed so that cost recovery of operational activities is ensured. Fee modulation instigates DfE by adjusting fees, in some cases beyond real EoL cost differences, so that fees are either lower (bonus) or higher (malus) than the average costs of the product range (Hogg et al., 2020^[6]). A balance is needed between providing DfE incentives and maintaining a sustainable cash flow for PROs. This modulation can generate problems in the financial equilibrium of the PRO. For example, a publicly-implemented EPR scheme for WEEE in Chinese Taipei offered a cost reduction to producers that participated in an eco-labelling scheme (Cheng et al., 2019^[28]). Unfortunately, the policy did not simultaneously control for an overprovision of the benefit relative to waste management costs and the

program was run at a deficit for four years before the discount rate was ultimately reduced (Cheng et al., 2019_[28]).

One way to balance the DfE incentives (bonus/malus) with a sustainable cash flow is to use fixed malus fees to finance a flexible bonus that will only be determined at a later moment when the revenues of the malus fees are clear (Hogg et al., 2020_[6]). At intervals, the PRO would calibrate the malus fees to ensure that incentives for DfE remain dynamic.

Alternatively, bonus fees could be fixed and the flexible malus fees calibrated at a later moment to finance the bonus payments. Whilst this option provides knowable incentives for producers to seek bonus payments, it may encounter more resistance from producers, as it creates uncertainties related to the magnitude of malus payments.

As the system adjusts over time and, if successful, more producers receive bonus payments and fewer pay malus fees, a need may arise to update bonus/malus fee structures to maintain DfE incentives.

Box 2. Product durability and fee modulation

Products can be grouped into two categories: those with a long use phase (durable products) such as EEE, furniture, and batteries, and those with a short phase or 'single use', such as packaging. Due to different characteristics in lifecycle, material content and environmental impacts, implications of advanced EPR fee modulation differ for durable and non-durable products:

- *Criteria:* Criteria intended to incentivise the extension of a product's lifespan (e.g. durability, reparability and upgradeability) are better suited to durable products. A re-use incentive is also useful for packaging.
- *Magnitude and method:* Durable products exhibit a smaller ratio between EPR fee modulation magnitudes and the product price than non-durable products. Especially for durable product groups, a fee modulation magnitude that exceeds EoL costs (e.g. through bonus/malus adjustments) may be needed to induce effects (see Section 4.2)
- *Harmonisation:* Durable products are more frequently designed and produced for several national markets or regions, which makes it more important to internationally align modulation criteria. Modulation in a single country may not provide sufficient incentive for DfE to justify production of a second product or to change product design for the entire market. In case criteria conflict across countries, the incentives are even more blurred.

Timing: EoL costs can only be measured with the current data and technology. Durable products have a longer use phase. The time lag between design and the incidence of EoL costs makes it more difficult to measure these costs and assign EPR fees accordingly

4.2. Magnitude of modulation

The magnitude of modulation (i.e. the difference in fee costs) relative to the product price determines the economic incentive for DfE. Where the ratio of the fee magnitude to product price is small, the incentive for DfE to lower their fee liability is low. Reversely, the higher the ratio of a fee magnitude relative to a product's price, the higher the incentive for the intended design change.

Table 11. 2020 PRO fees of the Belgian PRO for consumer electronics Recupel

Product	EPR fee (Recupel, Belgium, incl. VAT) (EUR)
Refrigerators and freezers	10
Washing Machine, dryer, dishwasher, vacuum cleaner	1
TV	5
Small household appliance (e.g. coffee machine, food processor)	0.05
Monitor	0.5
ICT Appliances (Laptop, printer, copier, keyboard)	0.05
Lawn mower, drill	0.005

Source: (Recupel, 2020^[29]).

One concern is that the advanced modulation of fees could increase complexity without providing sufficient incentive for design change by producers. This is most applicable for durable goods (see Table 11 of PRO fees for durable goods in Belgium). Even a doubling of the EPR fee (i.e. a malus of 100%) would only generate a limited incentive for DfE. In France, the portable battery EPR scheme SCRELEC provides for a bonus adjustment for recycled content, but the adjustment is less than one cent per battery and unlikely to change design choice (Hogg et al., 2020^[6]).

A second concern is around fee magnitudes that exceed observable differences in waste management costs. To further emphasise incentives, PROs can increase fee magnitudes with bonus/malus adjustments beyond observable cost differences in order to, for instance, create meaningful incentives for DfE. However, further adjustment of fees may raise concerns of arbitrariness which may lead to animosity in a competitive environment. Policymakers will need to conduct research and engage stakeholders to arrive at a fee adjustment that impacted parties can be expected to consider fair and legitimate.

4.3. Competition

The structure of the EPR fees and the modulation will affect competition in the product market. Indeed, producers with eco-friendly products will pay lower fees, whereas others must accept higher fees. The greater the magnitude of the modulation, the greater the benefit of an eco-friendly product.

This competitive differential is the whole point of modulation and is in line with the polluter pays principle. However, when designing the structure of modulation, two points have to be taken into account to safeguard long-term competition in the market:

- Where fees modulation diverges from measurable EoL cost differences, there is concern of “arbitrariness” and can provide producers with opportunities for capture. To avoid distorted competition in product markets, the modulation should be based on objective and observable product characteristics that can be evaluated for all products in the market/niche.
- An opaque or internationally detached price structure can create barriers to entry for new producers. The system of modulation has to be kept transparent and compatible with national and international good practices.

4.4. Harmonisation

Fee modulation can be expected to increase the complexity of an already heterogeneous EPR fee landscape (Hogg et al., 2020^[6]) (EXPRA, 2019^[30]) (APPLIA et al., 2019^[31]) (ORGALIM, 2019^[32]). Harmonising and coordinating EPR configurations between different PROs and states is important, to reduce administrative costs for firms in multiple markets, and to strengthen incentive structures for DfE through “pooling”.

Harmonisation is especially important in federal and quasi federal government systems that form a common or unified market. Ideally, reporting requirements and criteria should be harmonised, whilst exact monetary fees may differ according to national or local context (Wiesmeth and Häckl, 2017^[33]).

Furthermore, standardised reporting and efficient IT tools can minimise reporting burdens for firms, whilst improving comparability and compatibility of data across regions and countries.

Harmonising DfE incentives is particularly relevant for complex products such as EEE, batteries, or automobiles that are produced for the global market. If criteria can be aligned across multiple EPR systems, the “pooled” incentive for design change can possibly influence design beyond the geographic coverage of the respective EPR systems. Here, global initiatives could aim to coordinate criteria, such as in the G7 or the G20.

The EU Commission is currently working to establish harmonised legal criteria that guide Member States to a coordinated and uniform implementation (EXPRA, 2019^[30]).

Box 3. EPR in light of the digital transformation

IPR provides a complete internalisation for producers, but is typically cost inefficient in practice. Indeed, separating and returning products physically to producers increases costs and foregoes economies of scale (Rotter, Chancerel and Schill, 2011^[34]). However, as the digital transformation advances, IPR can come closer to reality through automated sorting, recognition via artificial intelligence (AI) and exact cost allocation between products and brands.

Increased availability and use of identifying technology, such as radio-frequency identification (RFID) will facilitate characterisation and sorting. Further, ‘brand tracing’ and ‘tag and tracing’ are relatively recent innovations that will improve reverse supply chain logistics.

Recycleye uses AI to identify and sort waste streams based on material and brand recognition. The technology is currently piloted in sorting facilities in the UK. Similarly, Recupel, the Belgian PRO for e-waste, is currently testing an AI-enhanced characterisation system for improved registration and sorting of incoming EoL products (Recupel, 2020^[35]).

4.5. Complexity and administration

The increased complexity of fee modulation increases the administrative costs for EPR implementation. Initially, costs will be incurred to design a set of modulation criteria for the fees. This process will require assessments of current practices, identification of desired future states and consultation amongst stakeholders.

A more complex system will also involve ongoing costs for PROs to maintain detailed data, monitor the reporting of firms and conduct data analysis. Moreover, the PRO or policy maker determining the modulation will need an in-depth understanding of recycling opportunities and design constraints. Criteria for modulation will also need to be considered and updated on a periodic basis to maintain the relevance to current industry conditions.

4.6. Design trade-offs

Fee modulation can change firms’ incentives for R&D investment and may come at the cost of innovations of other product characteristics. Examples of trade-offs may include losses in projected gains to functionality, lay-out, technical quality or durability. For instance, DfE for lighter, more recyclable food packaging or incentives to avoid food packaging, may increase food losses.

An empirical test of actual effects in design trade-offs has not been identified in this research, however economic models have explored this possibility. Findings include trade-offs between design for recyclability and:

- *Product Functionality and Technical Quality*: Brouillat and Oltra (2012^[36]) modelled the impact of different EPR fee modulations on R&D choices by firms related to three product characteristics: recyclability, lifetime of products, and technical quality. A modulated fee (compared with a fixed fee) was found to increase the share of R&D spending on recyclability, which resulted in improved recycling rates and reduced virgin material consumption. However, as R&D funds were redirected, it also led to shorter lifetimes and reduced technical quality of products. The modulated fee scenario also led to higher product prices and increased firm failure rate, but increased firm profits.
- *Durability*: Huang and Toktay (2019^[37]) modelled the trade-off between recyclability and durability, calibrated with data and assumptions by the EU's WEEE policy framework and the photovoltaic panels (PVP) industry. The model simulation projected that producers designed for recyclability at the opportunity cost of durability and vice versa depending on the stringency of the policy intervention for recycling or collection.
- *Re-usability*: Alev, Agrawal and Atasu's (2020^[38]) modelling study concludes that EPR criteria intended to increase recycling can lead to incentives for producers to interfere with re-use markets.

4.7. Free-riding and enforcement

Fee modulation schemes should be carefully designed to avoid additional compliance issues and free-rider risks. Especially for the EEE sector, 'free-riding' by producers that sell products via online platforms is an ongoing concern. One recent estimate is that freeriding applies for between 5-10% of the value of EEE in the OECD (Hilton et al., 2019^[39]).

Free-riding can be due to a lack of awareness, the complexity or insufficient enforcement of the EPR obligations (Hilton et al., 2019^[39]). Since advanced fee modulation will add further complexity to compliance, awareness campaigns will be needed to inform producers and platforms about the additional requirements for reporting. Examples of such awareness measures can include e-commerce codes of practice⁷, obligations for multi-seller online platforms to inform sellers about EPR obligations, and use of new technologies such as blockchain (Hilton et al., 2019^[39]).

At the same time, central authorities in markets (government and PROs) need to sufficiently control and enforce the requirements for fee modulation to ensure that producers are only rewarded for compliant innovations and effectively charged in case a malus applies.⁸ For example, in France, CITEO conducts external audits on at least 15% of the declarations by its client producers each year. External verification of reporting is particularly attractive for EPR systems with more than one PRO to avoid unintended incentives. External auditing parties also allow for more business confidentiality. In Italy, CONAI has dedicated a specific budget to the acquisition and processing of data from covered companies. In 2019, CONAI conducted over 1,200 targeted controls to monitor companies' application of its new procedures.

To ease enforcement, modulation criteria should be easily understandable, auditable and verifiable. Simple criteria allow for enforcement to be reliable, repeatable, and cost efficient (APPLIA et al., 2019^[31]). For example, claims by producers regarding 'availability of spare parts' or 'provision of technical information' for EEE can be easily verified by enforcement authorities. As well, policymakers can accompany fee modulation with standardised protocols for audits, compliance, and verification (see section 5.2 on

⁷ SafeShops.be is one such quality label with an accompanying code of practice, including a verification that sellers comply with national laws (Safe.Shop, 2018^[62]).

⁸ Hilton et al. (2019^[39]) present examples of measures to improve EPR compliance and good practices for enforcement. This working paper identified free-riding in transboundary online sales and has a focus on e-commerce.

Standards). Linking criteria to existing standards or other policy tools can also ease compliance for firms and enforcement (see section 4.4 on Harmonisation).

4.8. Governance

Governance in an EPR scheme is the organisation of roles and responsibilities of stakeholders (producers, public sector i.e. national and municipal governments, consumers, and retailers) (OECD, 2016^[40]). Modulating EPR fees adds complexity to governance and increases the importance of the institutional framework. Several challenging questions should be addressed in a governance system:

- Who should be involved in the decision-making about the criteria for fee-modulation and setting the magnitude of the fees?
- What is the process that should lead to these decisions?
- Which data sources and costing methodologies should be used?
- How and when should fees be revised and updated?

Box 4. EPR governance of Fee Modulation

Beginning in 2010, the EPR system for WEEE in France has introduced advanced fee modulation to improve the circularity of products. The governance structure contains clear objectives, responsibilities, review periods and monitoring for advanced fee modulation. National legislation determines the obligations for producers. A non-profit PRO owned by constituent member firms is subject to an accreditation process before the Commission Consultative d'Agrément (CCA) which sets the rules and recovery targets, for the PRO (Monier et al., 2014^[41]). The accreditation process occurs every six years and serves as a forum for regulators and stakeholders to discuss the goals and functioning of the EPR system.

PROs can become a forum for stakeholder engagement and can foster collaboration between recyclers and producers. For example, Ecosystem, a WEEE PRO in France, has a detailed governance system composed of a board of directors, sector, and administrative committees with members and administrators that proposes targets, initiatives, and R&D budgets (ECOSYSTEM, n.d.^[42]).

In Italy, the non-profit PRO, CONAI, is responsible for collective implementation of EPR for packaging. CONAI has established fee schedules that account for differences in actual EoL costs within some of the material groups, for example in plastics. In 2018, the PRO initiated different price levels for “product groups”, which were based on the assessment of a plastic consortium and the involvement of stakeholders (CONAI, 2020^[11]). The groups have since been updated through resolutions adopted by the board of directors to improve definitions and increase clarity of the system (CONAI, 2020^[11]).

There is no specific format to governance that is best to address these questions, but rather principles can guide the design of an effective governance framework:

Set clear and transparent objectives and goals: The objectives of an EPR scheme should be clearly stated and known by participants. The addition of fee modulation should be designed as a means to achieve the goal(s) of the scheme, for example by improving the recycling rate or recycled content of covered products. Targets of the program should be reviewed by stakeholders to optimise the functionality and to foster a sense of ownership (OECD, 2016^[40]).

Assign responsibilities for criteria setting and determination of the magnitude of modulation: Determining which actors will be responsible for selecting fee modulation criteria and the magnitude of modulation is of particular importance to ensure harmonisation of criteria within a state or within a market. PROs are likely

to have better information and be more responsive to producers' needs, but will be less likely to adjust fee magnitudes to a level required to set sufficient incentives for design change.

Offering PROs (in direct collaboration with producers) the opportunity to develop a proposal for criteria and modulation magnitude can lead to a better design and workability of modulated fees. If the PRO proposal is sufficiently in line with the government objectives, the government can ratify the proposal. Alternatively, the competent authorities can make modifications before transforming it into law.

Review criteria and fee magnitudes in an appropriate time frame: Intermittent review of fee modulation will be needed to ensure fee modulation is effectively improving outcomes. However, frequent revisions can send mixed policy signals and induce uncertainty to producers that need to commit to high upfront investments for product design changes. Therefore, the process and frequency of the reviews have to be clear as well as the link with the overall (long-term) objectives of the modulation. For example, CITEO has upfront established a process for increasing penalty fees for packaging. The system increases penalties from an initial 10% malus fee to a 'preventative' penalty of up to 100% after consultation with a committee for eco-design and eco-modulation (Hogg et al., 2020^[6]). This type of pre-arranged system for change, signals producers to phase out harmful materials or designs, while granting them a certain transition period.

Ensure enforcement, monitoring and reporting on all levels: advanced fee modulation will require increased resources for enforcement and monitoring. The institutional framework should clearly designate roles for PROs, producers, and municipalities with respect to reporting, audits and controls. Registers of producers, accreditation of PROs and inspections provide the public sector with the means for monitoring, while the PROs themselves should establish internal requirements for their producers for information sharing and expectations (OECD, 2016^[40]).

5. Advanced fee modulation in the context of a policy mix

Advanced EPR fee modulation is only one instrument to instigate DfE and additional policy tools can complement or in some cases replace advanced fee modulation (Box 5).

Box 5. Different approaches to brominated flame retardants (BFRs) and Recycling Inhibitors in different OECD countries

Different policy tools can be used to address problematic chemicals in products that inhibit recycling, such as Brominated Flame Retardants (BFRs) and other contaminants:

- In France, PROs established a *malus EPR fee adjustment* for EEE products (vacuum cleaners, computers, and game consoles) containing BFRs (EY, 2018^[15]). Similarly, graphic paper products with a presence of recycling inhibiting inks, glue, or varnish were subject to a *malus* (EY, 2018^[15]).
- Alternatively, a *tax* can be used to achieve the same incentive. For example, Sweden initiated a tax program on flame retardants used in electronic goods (Xuan, 2017^[43]).
- As a third alternative, *regulatory measures* can be used to set limits for concentration of harmful chemicals in products or can ban the presence of certain substances in products entirely. An example is the EU's Restriction of Hazardous Substances Directive 2002/95/EC.

Table 12 provides an overview of the main policy instruments that can be used as a complement to strengthen EPR with advanced fee modulation.

Table 12. Complementary measures to instigate DfE

Measure	Description	Relevant Life-cycle Stage(s)	Example(s)
Regulations (Bans, restrictions, requirements)	Regulations can be used to ban harmful substances in products, restrict their use or impose standards for material quality.	Design, Use, EoL	U.S.: a regulatory ban is in place barring the production of baby bottles with the chemical BPA due to concerns regarding health impacts. EU: the RoHS Directive restricts the use of hazardous substances in EEE, REACH legislation, POP legislation.
Product Standards and content requirements	Requirements for product content or processes.	Design, EoL	EU: Single-Use Plastics Directive requires plastic bottles to be made of at least 25% recycled content by 2025 and 30% recycled content by 2030
Taxes	Taxes on environmental impacts external to design decisions about end of life management and product performance.	Extraction, Design, Use, EoL	Denmark, Sweden, and the U.K.: Tax on use of virgin construction aggregate material (Söderholm, 2011 ^[44]).
Green Public Procurement	Public spending on green products creates demand for DfE products.	Design	U.S. EPA's Environmentally Preferable Purchasing Program
Indicators and Performance Evaluation	Targets and indicators for circularity set strong signals to industry.	Extraction, Design, EoL	Japan: 4 th Fundamental Plan for Establishing a Sound Material Society (Ministry of the Environment Government of Japan, 2018 ^[45]).
Research and Development	Fiscal support, property rights, and public research funds to support innovation in DfE.	Design, EoL	EU's Horizon 2020 CE-SC5-06-2018-2019-2020 Raw materials innovation for the circular economy
Information instruments	Improved information exchange between producers, recyclers, PROs, the public sector and consumers.	Design, Use, EoL	France: ecosystem's REECYC'LAB facilitates information between producers and processors at the design stage. Consumer-label: EU Ecolabel and energy efficiency label.

Source: Authors.

5.1. Regulations

Regulations, such as restrictions, bans or requirements send strong, binding signals about unwanted hazardous substances and minimum quality standards. For example, the EU has banned the use of Bisphenol A (BPA) (a chemical used to produce plastic) in baby bottles, France has banned BPA in all food packaging, and the U.S. Food and Drug Administration has banned BPA in baby bottles to avoid hazardous exposure of such products (Watkins et al., 2019^[46]).

Regulatory action may be more appropriate, where environmental or health risks outweigh private or public benefits of a product or substance. This can be either motivated by an evidence base or by the precautionary principle. Financial incentives from malus EPR fees or taxes, may be the preferred tool if the external risks are less substantial and/or depend on the application. (Table 13).

Table 13. Regulatory instruments

Description	Considerations as compared to advanced fee modulation	Possible advantageous alternative
Clear requirements or and restrictions/bans of product design.	<ul style="list-style-type: none"> • Effective at changing product design, but relatively inflexible • Strong market impact by entirely removing an otherwise marketable products. • Uncertain which products may replace the regulated items. 	<p>Hazards: Where environmental or health impacts or the risks thereof strongly outweigh private or public benefits of a product or substance. E.g. Hazardous substances in plastic food packaging or children toys.</p>

Source: Authors.

Furthermore, regulation can improve the recyclability and circularity of products by ensuring minimum quality requirements. For example, the EU's Directive on restricting the use of hazardous substances in electrical and electronic equipment (RoHS) specifies maximum levels for 10 restricted substances, intending to ease reuse and recycling (European Commission, 2020^[47]). The ongoing revision of the EU essential requirements (Packaging and Packaging Waste Directive 94/62/EC) for packaging and packaging waste is expected to strengthen minimum criteria for design for reuse and design for high quality recycling (European Commission et al., 2020^[48]).

5.2. Product standards and recycled content requirements

Product standards, such as recycled content targets, if set at the right level, can provide a strong *demand pull* for recycled material and create a need to increase both, the quantity and the quality of what is recycled. It can therefore be expected that recycled content requirements can provide sufficient incentives for producers to both increase recyclability and accelerate the uptake of secondary materials as inputs. As a complement to EPR, recycled content requirements can provide incentives for PROs to adopt measures such as advanced fee modulation and information sharing mechanisms to provide producers with additional incentives and know-how to design products that facilitate the supply of high-quality recycled material to meet product standards. For example, the EU Single-Use Plastics Directive requires plastic bottles to be made of at least 25% recycled content by 2025 and 30% recycled content by 2030 (European Parliament, 2019^[49]). Starting in 2022, California's Assembly Bill No. 793 will require a minimum share (up to 50% in 2030) of postconsumer recycled plastic for plastic beverage containers (California Legislative Information, 2020^[19]).

Product standards can also set minimum requirements for design of products to improve resource efficiency before recycling, such as by improving product durability and reparability. For instance, the EU Ecodesign Directive requires minimum lifetime criteria for components in some product groups (e.g. vacuum cleaners) and the availability of spare parts (for white goods) (European Commission, 2019^[50]). Both aim to increase product lifespans and contribute to waste prevention.

Finally, standards can serve to define processes that facilitate eco-modulation by harmonising criteria and improving comparability of product designs. For example, policymakers can clarify definitions and scope of the following characteristics that are possible modulation criteria: recyclability, recycling, reusability, and reparability. Existing horizontal standards (e.g. EN45554:2020 on reparability and EN45552:2020 on durability of energy-related products (CEN-CENELEC, 2020^[20]) can guide more product specific standards. As well, reporting and verification processes can be defined and standardised to facilitate a level playing field for PROs and producers and to move towards harmonisation of EPR systems.

5.3. Market based instruments

Market based instruments (taxes and tradable permits) can complement EPR fee modulation in instigating DfE, by internalising external costs along the lifecycle (Table 14).

For instance, the external costs of different waste disposal choices (landfill or incineration) of recycling residues are not priced into EPR fees, unless incineration and landfill taxes correct for these (Dubois and Eyckmans, 2014^[51]). Similarly, advanced EPR fee modulations will likely not fully capture differences in upstream environmental footprints of primary and secondary materials. Taxation on virgin materials is an important complementary policy to internalise upstream environmental damages and incentivise design changes.

Table 14. Advanced fee modulation in the context of policy alternatives

Measure	Description	Considerations as compared to advanced fee modulation	Possible advantageous alternative
Taxes	Internalise the costs of market choices by requiring actors to pay the external costs of their actions.	<ul style="list-style-type: none"> Requires public entities to set tax rates, collect and manage tax revenues. Tax rates can be decoupled from impact on EoL management costs. 	Appropriate to address environmental impacts outside of the EoL phase. E.g. energy efficiency of use-phase.
Cap and trade system	Cap and trade or creditable allowance systems set a quantitative target for industry. Tradeable permits (or credits) allow firms to achieve the target most cost-effectively.	<ul style="list-style-type: none"> Establishes incentives for dynamic efficiency Requires monitoring, enforcement, information and political feasibility to set the cap, as well as knowledgeable permit holders to successfully establish a market system. 	Where an economy-wide target for sustainable product design is desired. E.g. recycled content in plastic bottles.

Source: Authors.

A *tax policy instrument*, similar to EPR fee modulation, aims to correct economic incentives for design choices by incorporating external costs in decision-making. In a tax system, the public sector determines the tax rate and receives the revenues, whereas in a collective EPR systems the fee or malus payment contributes to PRO budgets for end-of-life management of products.

A *cap and trade system* can encourage DfE by establishing a quantitative target for design changes that allows producers to implement these targets most cost-effectively. For example, public entities could set a target for recycled content for a sector. Permits may be traded between producers that surpass the target and producers that are not able to achieve this target. Depending on the criteria, setting an economy-wide or sector-wide target for design change could be more easily monitored. However, if an EPR system is already in place for the targeted products, modulating fees may be an easier approach than setting up a new dedicated cap and trade system.

5.4. Green public procurement (GPP)

Providing guidance for public spending can strengthen demand of more circular products and further encourage their development, design and production. Across OECD member countries in 2017, public procurement accounted on average for 12% of GDP (OECD, 2019^[52]). For example, the U.S. EPA provides an Environmentally Preferable Purchasing Program to guide public procurement of goods towards more sustainable products.

GPP is an effective *demand-pull* measure, in complement to advanced EPR fee modulation that intends to improve the supply of these products (*supply-push* measure). Bonus/malus adjustments in advanced fee modulation can also provide a reference for GPP and thus lead to synergies.

5.5. Indicators and performance evaluation

Indicators and targets for performance related to circularity (e.g. recycling or reuse rates) send a clear signals to industry and consumers about future expectations. Moreover, indicators allow to track progress towards the set goals (Morseletto, 2020^[53]).

Indicators and targets are also an important element in advanced EPR fee modulation. They help to determine the criteria and magnitude of modulation and enable performance evaluations.

5.6. Research and development

Governments support R&D efforts in DfE with direct funding, tax incentives and protection of intellectual property. Advanced fee modulation can complement these incentives for more DfE.

An example is the EU research and innovation program Horizon 2020⁹, which provided close to EUR 80 billion R&D funding over 7 years, among others for the development of new technologies and materials (European Commission, 2020^[54]). The leveraging effect of public investment on private R&D is estimated to range between 0.23 percent per 1 percentage increase in spending within the same year of expenditure to 1.32 percent in the long run (Mohanty, 2020^[55]).

The public sector can stimulate investment in R&D with tax credits on incremental or total R&D expenditure (Straathof et al., 2014^[56]). These can be tailored to R&D in innovation for DfE.

Protection of intellectual property, for instance through fostering patenting, also encourages companies to invest in costly innovations. For example, Arora, Ceccagnoli, and Cohen's study (2008^[57]) of manufacturing in the U.S. found that patenting provides an expected net premium for some industries and thus stimulates private investment in R&D.

5.7. Information instruments

Information tools can be useful complements to EPR fee modulation to improve decision-making. Consumer labels and product certificates, for instance, can help consumers to make more informed purchasing decisions (Laubinger & Börkey, 2021, forthcoming). When aligned with EPR fee modulation criteria, labels and certificates can serve to strengthen the marketing effect.

Visibility of EPR fees and bonus/malus modulations in itself can also have a signalling function to consumers and producers. If disclosed, a "bonus" allows product designers, as well as consumers and procurement departments from companies or governments to identify environmentally preferable products (see Box 6).

Box 6. Signalling function of EPR fees

A key benefit of EPR eco-modulation can be the *signalling function* for producers and consumers.

Besides the price incentive, a bonus/malus adjustment signals preferable design choices to producers. Additionally PROs, together with recyclers, could indicate alternative design solutions that improve recyclability.

Disclosed modulated EPR fees can also guide consumer choices and steer demand. Visible fees are mandatory for some product groups in some jurisdictions (e.g. for EEE in France). If there is a significant enough difference in the fees, visible fees can impact consumer choice. Additionally, visible EPR fees increase transparency and can encourage competitive prices among PROs. Visible fees in product prices can also indicate compliance by producers and retailers and reduce free-riding. Brouillat and Oltra's model projects that modulated fees visible to consumers can spur improvements in recyclability and design for recycling (2012^[36]).

Initial experience from France shows, that, while 'visible', the small amount of bonus/malus in relation to the product cost is unlikely to substantially affect consumer's choices and the impact on a product's market share is limited. Nevertheless, a visible fee signals to the consumer the existence of an EoL

⁹ From 2021-2027 the program is titled Horizon Europe.

cost associated to their purchased product, which can encourage appropriate sorting and recycling (Hogg et al., 2020^[6]).

Additionally, PROs can facilitate communication along all actors of the value chain. This may reveal easily implementable product design changes, without the necessity to modulate fees (Atasu, 2019^[58]). For example, in France, the PRO “Ecosystem” developed a database-driven tool (REECYC’LAB) for product designers to assess recyclability and to receive suggestions to improve the circularity of their designs (Ecosystem, 2020^[59]).

Finally, PROs can organise consumer awareness campaigns and ensure aligned messaging.¹⁰

¹⁰ In most EPR systems, some commitments to information and awareness campaigns is required.

6. Key policy insights

One of the key objectives of EPR is to foster DfE. Since the costs of IPR are high, industry and policy makers have opted for collective EPR systems where producers pay fees to a PRO that takes care of these obligations. The EPR fees typically only contain basic modulation with weak incentives for DfE. Advanced fee modulation can provide producers with stronger DfE incentives, but the tool is expected to increase the accompanying administrative burden.

Some EPR systems have started to apply advanced fee modulation, but the experience is limited. However, some policy insights and good practices can already be put forward:

1. EPR systems need clear objectives, periodic reviews and evaluations. Long-term objectives ensure predictability and reduce uncertainty about short-term changes. Periodic reviews and evaluations improve the effectiveness and relevance of fee modulation.
2. Existing stakeholder networks in EPR systems can be instrumental in collecting insights for determining feasible and effective modulation criteria and for coordinating between producers and recyclers.
3. The lessons learned by first implementers can inform future policy efforts.
4. The criteria and magnitude of fee modulation determine the direction and strength of DfE incentives for producers. Therefore it is important that criteria are:
 - Easily understandable, auditable, and enforceable.
 - Harmonised in federal and semi-federal systems. Policymakers may need to seek coordination across regional or global markets, where this is politically feasible to avoid barriers for trade and ease compliance by firms acting on international markets.
5. Non-durable products, such as packaging, exhibit a higher fee to product price ratio than durables and are thus more sensitive to fee modulations. Durable products tend to be designed for several national markets, which makes international harmonisation of modulation criteria more necessary to achieve DfE. Therefore, non-durable products may lend themselves better to advanced fee modulation.
6. Advanced fee modulation is only one tool in a larger policy mix to encourage resource efficiency through DfE. Fee modulation can be complemented by and aligned with additional policy tools, including:
 - Recycled content requirements to provide a strong *demand pull* for high-quality recycled material. PROs may voluntarily decide to introduce fee modulation to help them achieve increased quantity and quality of recycled material to achieve recycled content targets.
 - Green Public Procurement criteria can be aligned with EPR fee criteria to strengthen demand.
 - Market based instruments can be used to correct for negative impacts external to the EPR system, including impacts of virgin material extraction and final disposal of recycling residues.
 - Hazardous substances bans and product requirements can ensure minimum product standards for aspects that involve significant hazards to environmental or human health.
7. Additional complexity of advanced fee modulation requires cost-effective data collection and management capacity. This may be more easily available in mature EPR systems. It is therefore advisable to begin with basic fee modulation when a new EPR is established, so as to minimise complexity of initial implementation.

References

- Afvalfonds Verpakkingen (2018), *Plastic Fee Modulation Scheme*, [10]
<https://afvalfondsverpakkingen.nl/a/i/Plastic-Fee-Modulation-Scheme.pdf> (accessed on 2 February 2021).
- Alev, I., V. Agrawal and A. Atasu (2020), “Extended producer responsibility for durable products”, [38]
Manufacturing and Service Operations Management, Vol. 22/2,
<http://dx.doi.org/10.1287/MSOM.2018.0742>.
- APPLIA et al. (2019), “Joint industry comments on modulating producers’ financial contributions for Waste Electrical and Electronic Equipment - DIGITALEUROPE”, [31]
<https://www.digitaleurope.org/resources/joint-industry-comments-on-modulating-producers-financial-contributions-for-waste-electrical-and-electronic-equipment/> (accessed on 28 September 2020).
- Arora, A., M. Ceccagnoli and W. Cohen (2008), “R&D and the patent premium”, [57]
International Journal of Industrial Organization, Vol. 26/5, <http://dx.doi.org/International Journal of Industrial Organization>.
- Atasu, A. (2019), “Operational Perspectives on Extended Producer Responsibility”, [58]
Journal of Industrial Ecology, Vol. 23/4, pp. 744-750, <http://dx.doi.org/10.1111/jiec.12816>.
- BMJV Germany (2019), *Gesetz über das Inverkehrbringen, die Rücknahme und die hochwertige Verwertung von Verpackungen (Verpackungsgesetz-VerpackG)*, <http://www.gesetze-im-internet.de/verpackg/VerpackG.pdf> (accessed on 9 September 2020).
- Brouillat, E. and V. Oltra (2012), “Dynamic efficiency of extended producer responsibility instruments in a simulation model of industrial dynamics”, [36]
Industrial and Corporate Change, Vol. 21/4, <http://dx.doi.org/10.1093/icc/dtr071>.
- California Legislative Information (2020), *PUBLIC RESOURCES CODE-PRC DIVISION 30. WASTE MANAGEMENT [40000-49620] (Division 30 added by Stats,* [19]
https://leginfo.ca.gov/faces/codes_displayText.xhtml?lawCode=PRC&division=30.&title=&part=3.&chapter=20.&article=.
- CEN-CENELEC (2020), *CEN/CLC/JTC 10 Published Standards*, [20]
https://standards.cen.eu/dyn/www/f?p=204:32:0:::FSP_ORG_ID,FSP_LANG_ID:2240017,25&cs=1D4156C3D679EE526A476E8463ACFAA98 (accessed on 4 March 2020).
- Cheng, C. et al. (2019), “Determining environmental costs: A challenge in a governmental e-waste recycling scheme”, [28]
Sustainability (Switzerland), Vol. 11/19,
<http://dx.doi.org/10.3390/su11195156>.
- CITEO (2021), *French regulatory framework on the Green Dot*. [63]
- CITEO (2019), *The 2020 rate for recycling household packaging*, <https://www.citeo.com/le-mag/le-tarif-2020-pour-le-recyclage-des-emballages/> (accessed on 7 October 2020). [9]

- CONAI (2020), *Contribution Diversification for plastic packaging*, [61]
<http://www.conai.org/en/businesses/environmental-contribution/contribution-diversification-for-plastic/> (accessed on 16 September 2020).
- CONAI (2020), *Lists of plastic packaging in the Contribution levels*, [11]
http://www.conai.org/wp-content/uploads/2020/03/Lists_of_plastic_packaging_in_the_Contribution_levels_2020-1.pdf
 (accessed on 8 September 2020).
- CONAI (2019), *Contribution diversification for plastic packaging-Experimental Sorting/Recycling Activities*, [27]
https://www.conai.org/wp-content/uploads/2020/11/Trials_in_progress_as_at_26_11_2019.pdf (accessed on 12 February 2021).
- CONAI (2018), *CONAI Green Economy Report 2018*, [26]
http://www.conai.org/wp-content/uploads/2019/12/Green_Economy_Report_Conai_EN.pdf (accessed on 5 October 2020).
- Dubois, M. and J. Eyckmans (2014), “Efficient Waste Management Policies and Strategic Behavior with Open Borders”, *Environmental and Resource Economics*, Vol. 62/4, pp. 907-923, [51]
<http://dx.doi.org/10.1007/s10640-014-9851-3>.
- Eco-Mobilier (2018), *Eco-fee pricing scale with eco-modulation*, [23]
https://www.eco-mobilier.fr/wp-content/uploads/2018/09/bareme_eco-modulation-uk-2018_v3.pdf (accessed on 28 September 2020).
- ECOSYSTEM (n.d.), *Our Governance*, [42]
<https://www.ecosystem.eco/en/article/governance>.
- Ecosystem (2020), *REECYC'LAB: An Educational Simulator to Understand, Assess, and Improve the Recyclability of Your New Product*, [59]
<https://reecyclab.ecosystem.eco/?locale=en>
 (accessed on 15 October 2020).
- ECO-TLC (2019), *NOUVEAUX CRITERES DURABILITE et PERIMETRE PRODUITS CONCERNES Eco Modulation 1 «durabilité » (bonus de 50 %)*, [24]
https://refashion.fr/pro/sites/default/files/fichiers/Crite%CC%80res%202020%20Eco%20modulation%201_durabilite%CC%81%20%281%29.pdf (accessed on 28 September 2020).
- EEQ (2020), *Credit for post-consumer recycled content*, [18]
<https://www.eeq.ca/en/faq/prepare-report/am-i-entitled-to-the-credit-for-post-consumer-recycled-content/> (accessed on 28 November 2018).
- EPR Canada (2017), *Summary of advancements in EPR policy and programs in Canada during 2016*, [60]
<http://www.eprcanada.ca/reports/2016/EPR-Report-Card-2016.pdf> (accessed on 28 November 2018).
- EU Lex (2018), *DIRECTIVE (EU) 2018/851 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2018 amending Directive 2008/98/EC on waste (Text with EEA relevance)*, [5]
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.150.01.0109.01.ENG (accessed on 16 November 2018).
- EUR Lex (1994), “Directive 94/62/EC of 20 December 1994 on packaging and packaging waste”, [14]
Official Journal of the European Commission, Vol. 365, pp. 10-23, <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31994L0062&from=EN>.

- European Commission (2020), *Electrical and electronic waste-Environment-European Commission The RoHS Directive*, [47]
https://ec.europa.eu/environment/waste/rohs_eee/index_en.htm.
- European Commission (2020), *Horizon 2020 Work Programme 2018-2020 12. Climate action, environment, resource efficiency and raw materials*, [54]
<https://ec.europa.eu/programmes/horizon2020/en/h2020-section/climate-action-environment-resource-efficiency-and-raw-materials> (accessed on 28 September 2020).
- European Commission (2019), *The new ecodesign measures explained*, [50]
https://ec.europa.eu/commission/presscorner/detail/en/QANDA_19_5889 (accessed on 5 February 2021).
- European Commission et al. (2020), *Effectiveness of the essential requirements for packaging and packaging waste and proposals for reinforcement*. [48]
- European Parliament (2019), *Parliament seals ban on throwaway plastics by 2021*, European Parliament, [49]
<https://www.europarl.europa.eu/news/en/press-room/20190321IPR32111/parliament-seals-ban-on-throwaway-plastics-by-2021>.
- EXPRA (2019), "Towards a common approach to modulated fees", [30]
http://www.expra.eu/downloads/expra_position_paper_towards_a_com.pdf (accessed on 28 September 2020).
- Expra (2018), *Summary record: Expert talk: "Eco-modulation of EPR fees as a tool towards a circular economy"*, [7]
http://www.expra.eu/uploads/downloads/events/Summary%20Report_Expert%20Talk%209%20October%202018.pdf (accessed on 20 November 2018).
- EY (2018), *Study on the implementation of eco-design incentives in Extended Producer Responsibility*. [15]
- EY (2016), *Exploration of the Role of Extended Producer Responsibility for the circular economy in the Netherlands*, [16]
[https://www.ey.com/Publication/vwLUAssets/ey-exploration-role-extended-producer-responsibility-for-circular-economy-netherlands/\\$FILE/ey-exploration-role-extended-producer-responsibility-for-circular-economy-netherlands.pdf](https://www.ey.com/Publication/vwLUAssets/ey-exploration-role-extended-producer-responsibility-for-circular-economy-netherlands/$FILE/ey-exploration-role-extended-producer-responsibility-for-circular-economy-netherlands.pdf) (accessed on 16 November 2018).
- Förpacknings och Tidnings Insamlingen (n.d.), "Instructions 01-01-2019", [12]
<https://ftiab.se/download/18.5da2a47216c96d761ae62d/1567671034254/Instructions%2001-01-2019.pdf> (accessed on 28 September 2020).
- Fostplus (2020), *Green Dot rates 2021*, [8]
https://www.fostplus.be/sites/default/files/Files/Bedrijven/GPtarieven/groenepunttarieven_2021_eng_v3.pdf (accessed on 13 August 2020).
- Hilton, M. et al. (2019), "Extended Producer Responsibility (EPR) and the Impact of Online Sales", *OECD Environment Working Papers*, No. 142, OECD Publishing, Paris, [39]
<https://dx.doi.org/10.1787/cde28569-en>.
- Hogg, D. et al. (2020), *Study to Support Preparation of the Commission 's Guidance for Extended Producer Responsibility Schemes*, Eunomia Research & Consulting. [6]

- Huang, X., A. Atasu and L. Beril Toktay (2019), “Design implications of extended producer responsibility for durable products”, *Management Science*, Vol. 65/6, <http://dx.doi.org/10.1287/mnsc.2018.3072>. [37]
- Joltreau, E. (2018), “Pricing products’ negative externalities at end-of-life using eco-modulation: Discussion from case studies”, *Economics and Policy of Energy and the Environment*, Vol. 2018/1, <http://dx.doi.org/10.3280/EFE2018-001007>. [25]
- Lindhqvist, T. (2000), *Extended Producer Responsibility in Cleaner Production Policy Principle to Promote Environmental Improvements of Product Systems*, IIIIEE, Lund University, <https://lup.lub.lu.se/search/ws/files/4433708/1002025.pdf> (accessed on 16 September 2020). [2]
- Ministerio del Medio Ambiente Chile (2021), *Decreto-12: Establece Metas de Recolección y Valorización y Otras Obligaciones Asociadas de Envases y Embalajes*, Ley Chile, <https://www.bcn.cl/leychile/navegar?idNorma=1157019> (accessed on 7 June 2021). [13]
- Ministry of the Environment Government of Japan (2018), *Fundamental Plan for Establishing a Sound Material-Cycle Society*, https://www.env.go.jp/en/recycle/smcs/4th-f_Plan.pdf (accessed on 28 September 2020). [45]
- Mohanty, A. (2020), *The relationship between public and private R&D funding*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/897470/relationship-between-public-private-r-and-d-funding.pdf (accessed on 28 September 2020). [55]
- Monier, V. et al. (2014), *Development of Guidance on Extended Producer Responsibility (EPR) FINAL REPORT European Commission-DG Environment 2014 In collaboration with*, https://ec.europa.eu/environment/waste/pdf/target_review/Guidance%20on%20EPR%20-%20Final%20Report.pdf (accessed on 28 September 2020). [41]
- Morseletto, P. (2020), “Targets for a circular economy”, *Resources, Conservation and Recycling*, Vol. 153, <http://dx.doi.org/10.1016/j.resconrec.2019.104553>. [53]
- OECD (2019), *Government at a Glance 2019*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/8ccf5c38-en>. [52]
- OECD (2016), *Extended Producer Responsibility: Updated Guidance for Efficient Waste Management*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9789264256385-en>. [1]
- OECD (2016), *Extended Producer Responsibility: Updated Guidance for Efficient Waste Management*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9789264256385-en>. [40]
- OECD (2001), *Extended Producer Responsibility: A Guidance Manual for Governments*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9789264189867-en>. [3]
- ORGALIM (2019), “Eunomia Study in support of developing Guidance for Extended Producer Responsibility (EPR) Schemes: Comments on modulation of producers’ financial contributions”, <https://orgalim.eu/position-papers/eunomia-study-support-developing-guidance-extended-producer-responsibility-epr> (accessed on 28 September 2020). [32]
- Pro Europe 4 Prevention (2018), *Packaging’s trends*, <https://www.proeurope4prevention.org/packagings-trends> (accessed on 16 November 2018). [4]

- Recupel (2020), *Artificial intelligence in our sorting process*, [35]
<https://www.recupel.be/en/blog/artificial-intelligence-in-our-sorting-process/> (accessed on 9 October 2020).
- Recupel (2020), *Recupel contribution on electro-appliances. Tariffs valid from 1st July 2020.*, [29]
https://www.recupel.be/media/2455/appliancelist_2020_eng.pdf (accessed on 6 October 2020).
- Rotter, V., P. Chancerel and W. Schill (2011), “Practicalities of individual producer responsibility under the WEEE directive: experiences in Germany”, *Waste Management & Research*, Vol. 29/9, pp. 931-944, <http://dx.doi.org/10.1177/0734242x11415753>.
- Safe.Shop (2018), *The Safe.Shop Code of Conduct Checklist*, https://www.safeshops.be/wp-content/uploads/2018/02/Code_of_Conduct_Checklist.pdf (accessed on 16 October 2020). [62]
- SCRELEC (2019), *BARÈME SCRELEC 2020 Applicable au 1 er Janvier 2020*. [22]
- Söderholm, P. (2011), *Taxing virgin natural resources: Lessons from aggregates taxation in Europe*, <http://dx.doi.org/10.1016/j.resconrec.2011.05.011>. [44]
- Straathof, B. et al. (2014), *A Study on R&D Tax Incentives*, Office for Official Publications of the European Communities, Luxembourg, <http://dx.doi.org/10.2778/29775>. [56]
- VALORPNEU (2018), *TABELA DE ECOVALOR*, <https://www.valorpneu.pt/tabela-de-ecovalor/>. [21]
- Watkins, E. et al. (2019), “OECD Sustainable Plastic Design”, *OECD Environment Working Papers*, Vol. 149, <https://doi.org/10.1787/233ac351-en>. (accessed on 28 September 2020). [46]
- Wiesmeth, H. and D. Häckl (2017), *Integrated environmental policy: A review of economic analysis*, <http://dx.doi.org/10.1177/0734242X16672319>. [33]
- Xuan, J. (2017), “Sweden Introduces Tax on Certain Chemical in Electronics Law, 2016:1067”, SGS, <http://rkrattsdb.gov.se/SFSdoc/16/161067.PDF>. [43]