

# **EXTENDED PRODUCER RESPONSIBILITY FOR PACKAGING– INDUSTRY PERSPECTIVE FROM A GLOBAL COMPANY**

Igor Karlovits<sup>1,2</sup>

<sup>1</sup>Danfoss Power Solutions, Danfoss Trata doo, Ljubljana, Slovenia

<sup>2</sup>National Institute of Chemistry, Ljubljana, Slovenia

doi: 10.5281/zenodo.17295166

igor.karlovits@danfoss.com

**Abstract:** *This paper provides a global manufacturing company's perspective (with more than 100 business units in almost all continents) on Extended Producer Responsibility (EPR) for packaging, focusing on the implications of its implementation and outcomes in the United States and the European Union, and some other countries introducing EPR schemes. EPR schemes shift the financial and/or operational responsibility for the end-of-life management of products, including packaging, from municipalities to producers. For a global company, this policy instrument (taxes and fees) aims to incentivize the design of more sustainable products, reduce waste generation, and increase recycling rates across diverse markets. On the other hand, the overly complex policy landscape with non-harmonized requirements poses a challenge in terms of designing, reporting, and policy compliance. The paper summarizes the requirements that would enable a more systemic approach to the EPR schemes for different states/countries. Also, company strategies are presented through systemic design choices based on sustainability and regulatory requirements through eco-modulation and eco-design of the products.*

**Keywords:** Extended Producer Responsibility, compliance, eco modulation

## **1 INTRODUCTION**

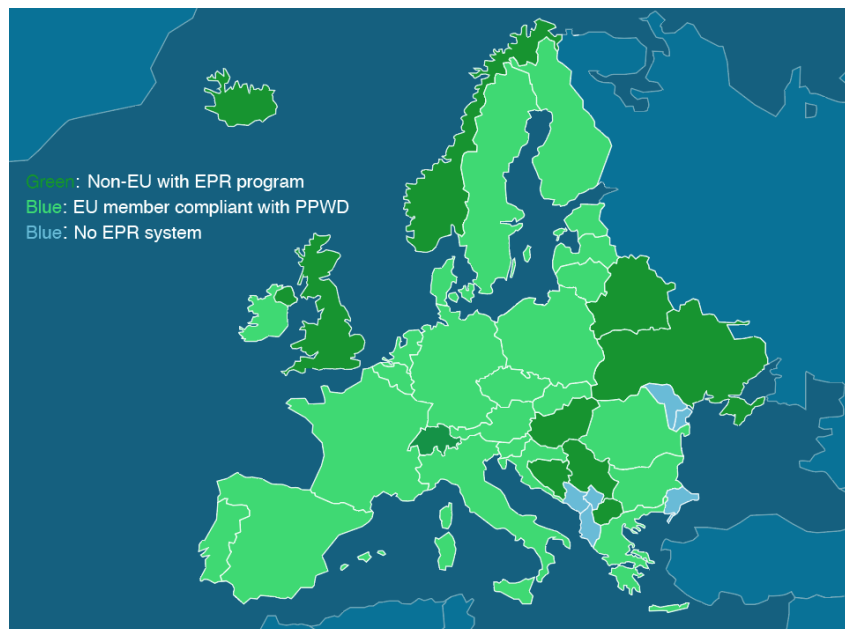
Extended producer responsibility (EPR) is another economic tool (like the plastic taxes) whose aim is to incentivise behaviour change by changing the market and legal requirements of stakeholders. EPR is basically a policy approach that makes producers responsible for their products along the entire lifecycle, including at the post-consumer stage. By doing so, it helps achieve environmental goals such as recycling targets. At the same time, EPR generates funding from producers that help to pay for the collection, sorting, and recycling of waste products, as well as generates detailed information on production, products, waste generation, and treatment (OECD, 2016). In the last few years in many cases, it is also been a tool mainly aimed to contain plastic pollution in with developed and developing countries (UNEP, 2022).

Effectively, EPR has two principal environmental goals:

- To provide incentives for manufacturers to design resource-efficient and low-impact products (through eco design incentives or so-called eco modulation fees or bonus/malus systems).
- To ensure effective end-of-life collection, the environmentally sound treatment of collected products, and improved rates of reuse and recycling (through collective additional funds

through fees to scale up infrastructure, which would receive materials suitable for recycling – based on the first goal).

The origins of EPR systems stem from the early 1990s in the EU. The Packaging and Packaging Waste Directive (94/62/EC) (PPWD) in 1994 marked the first major legislative application, requiring producers to finance or organize the recovery and recycling of packaging waste. In its early form, the focus of EPR in the EU was end-of-life waste management, and implementation was largely voluntary or industry-led. (Michaelis, 2025). Two other crucial EU documents have paved the way for the EPR schemes in the EU: first the Green Deal from 2019 and the Circular Economy Action Plan in 2020 (CEAP), which explicitly defines EPR as a central policy instrument, and lays out concrete actions to expand and harmonize it. EPR was set up as a driver of sustainable design, circularity, and green innovation, not just waste handling. The extent of the EPR adaptation in the EU is summarized in Figure 1. (Webster, 2025).



*Figure 1: EPR systems in Europe (Webster, 2024)*

Nations that fall under the PPWD (indicated in light green) include EU member states: Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden. Countries that are not in the European Union have also developed their own approaches to EPR, many of which align with the European Union's Directive. These countries are marked in dark green on the map, including the United Kingdom, Iceland, Serbia, Belarus, North Macedonia, Bosnia and Herzegovina, Norway, Switzerland, and Ukraine. The UK has its own system.

So, from the overview, we can see the European landscape is quite complex with many different solutions, and combining state level plastic tax variations makes the single market difficult to navigate. One recent court decision from the Court of Justice of the EU (CJEU) has issued a final ruling in favor of Slovenia's new Extended Producer Responsibility (EPR) scheme in the case *INTERZERO and Others v Državni zbor Republike Slovenije* (Case C-254/23). This court ruling is important not just for Slovenia but also can trigger changes again in countries with competing PROs if policymakers see that the Single PRO setup is more beneficial. While this does not directly concern producers, more pressure is on the profit loss of waste management companies – the additional changes can cause potential problems due to changes and adaptations.

The extent to which EPR has spread to other countries and continents is well presented by Figure 2. This gives a global overview of the EPR schemes (Webster, 2024).



*Figure 2. EPR systems in place (Webster, 2024)*

From different overviews by (Clarity, 2024), (Bünemann et al., 2020), we can see that in the Americas, for example, the United States, EPR laws and programs currently operate at a state-by-state basis, with no federal program in existence. There is a common Producer Responsible Organization (PRO) collecting the fees and dealing with reporting. There are currently 6 states who have running EPR schemes in place (Maine, Oregon, Colorado, California, Maryland, and Minnesota) and several other states with EPR schemes in perspective in the near future. While the reporting is through one PRO, the Circular Alliance, the requirements differ from state to state. Canada also has several EPR schemes and similar to the US approach, the establishment of EPR programs are managed by individual provinces, not federally (Alberta, British Columbia, Manitoba, New Brunswick, Nova Scotia, Ontario, Quebec, Saskatchewan, and Yukon). In Central and South America (Dominican Republic, Costa Rica) and Colombia, Venezuela, Chile, Brazil, Peru, and Uruguay have EPR installed.

In Asia, Russia, China, Taiwan, Singapore, India, Saudi Arabia, South Korea, Japan, Vietnam, Philippines, Indonesia, Kazakhstan have EPR systems, and in Oceania Australia, New Zealand lead the way with implemented EPR systems.

All these systems have their specific rules and fees, which makes requirements from a global company producing and placing into different markets a huge effort in compliance with the local EPR schemes. It is important to note that Danfoss is a manufacturing company, and the largest number of EPR schemes are focused on consumer level packaging, so due to specific rules these types of companies are exempt from many EPR schemes. But nevertheless, such companies are in scope in some of the companies, so the knowledge and oversight of all requirements are still needed. In our cases, due to complex business structures, we have some segments producing also business to customers and some just business to business to which just adds to the complexity for these type of companies. While exact global ratios are not consistently published, based on regulatory coverage:

- B2C packaging likely accounts for 70–85% of the EPR scope globally.
- B2B packaging makes up the remaining 15–30%, depending on national definitions and exemptions.

## 2 ECO MODULATION AND ECO DESIGN

Eco-modulation adjusts EPR fees based on the environmental performance of packaging:

- Lower fees for packaging that aligns with eco-design principles
- Higher fees for packaging that is hard to recycle, contains toxic materials, or generates more waste

While the factors considered in eco-modulation vary from law to law, in the packaging context, the factors usually fall under end-of-life factors and life cycle factors. End-of-Life Characteristics include: Recyclability, Compostability, Presence of hazardous substances, Clear consumer labelling; while Life Cycle Characteristics include: use of renewable or recycled materials, Reusability, Greenhouse gas emissions during production. (Sayegh, 2025) France (and some other EU countries ) use the Bonus/malus system, where producers receive reductions in fees (the bonus) for using packaging that is recyclable, contains post-consumer recycled (PCR) content, or is reusable. Conversely, fee increases (maluses) apply to packaging with harmful substances or poor recyclability. As a result, producers can receive a deduction of up to 24% of the amount due or, in contrast, be penalised by paying more than 100% of the basic fee (EU Commission, 2016). Paper companies pay 10% less (bonus) if they use packaging with more recyclable material, but 5% more (malus) if they use unsustainable fibres or introduce materials, like ink or glue, into the recycling system. Lower Fees also include packaging made from mono-materials that are easily recyclable, use of certified compostable materials, and inclusion of >30% PCR content. Higher fees are induced for: multi-layer plastic films, packaging with carbon black (hard to sort), or, for example, Use of PVC or other non-recyclable plastics and can bring up to 100% extra fee. The exact amount is calculated based on The exact malus rate depends on the packaging weight, number of packaging units, placement (closures, films, containers), and the industrial sector. The Danish system is planned to have three levels (green, yellow, and red) with a malus of 35% on top of their calculated operational costs for waste management of all packaging in the red category. A workflow of how this system works is presented in Figure 3 (Vana, 2025).

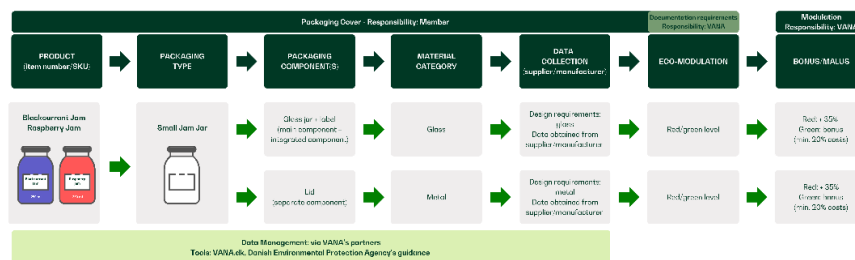



Figure 3: Danish EPR determination for bonus/malus (Vana, 2025)

Similar characteristics are also considered in US states which introduced EPR (Piece, 2025) is presented in Figure 3.



STATE-BY-STATE ECO-MODULATION FACTORS CONSIDERED

FACTOR	CALIFORNIA	COLORADO	MAINE	MINNESOTA	OREGON
RECYCLING RATE	X				X
PCR	X	X	X	X	X
REUSE	X	X	X	X	
LIGHT-WEIGHTING	X	X		X	
RECYCLABILITY	X	X	X	X	
RENEWABLE SOURCING	X			X	
TOXICS	X		X	X	
LABELING	X		X		
COMPOSTING	X			X	
REDUCTION	X	X	X		
PACKAGE TO PRODUCT RATIO					X
LIFE CYCLE ASSESSMENT					X
MATERIAL CHOICE					X

Figure 4: Danish EPR determination for bonus/malus (Vana, 2025)

### 3 OUR SOLUTION

To achieve the multi level requirements (compliance, quality, decarbonization efforts, production efficiency) a packaging framework is used which is presented in Figure 5.

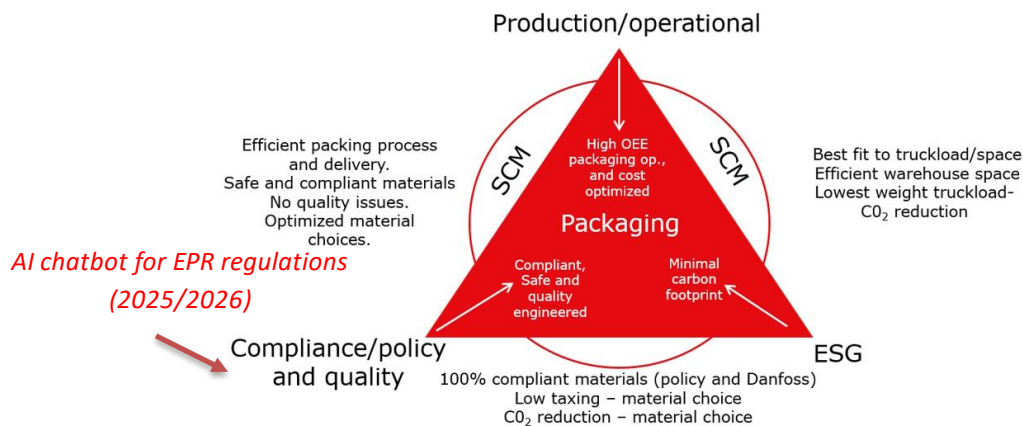


Figure 5: Danfoss Power Solutions packaging framework

The DPS packaging framework uses company packaging standards, which defines the preferred materials that are updated every second year. Operational efficiency is calculated through the mechanical characteristics of the required materials to achieve efficient production, picking, and packing. Sustainability is cross-checked with an internal Sustainable Packaging Assessment Tool or a full LCA analysis to decide if one-way or returnable packaging is the best option. Here, we aim for the minimization of eCO<sub>2</sub> of the whole packaging material and lifecycle with the highest possible recycled content of materials. The compliance and quality requirements were mostly manually checked through consultation with companies. With the implementation of artificial intelligence and internal chatbots throughout the company, similar technology is planned to cover the EPR/legal requirements regarding packaging. By feeding into the system all the legal documents and eco modulation materials, we are expecting to at least decrease the time needed to get the most efficient solution with the lowest eCO<sub>2</sub> and the lowest fees with maximum bonuses for most of the countries where we place our products.

### 4 CONCLUSIONS

Based on the current EPR landscape and compliance requirements and the upcoming PPWR regulation in the EU, as a company, we are introducing EPR awareness already in the design and procurement

stage through the combination of internal tools, the packaging framework, and an AI chatbot to guide us through regulatory requirements. For industry stakeholders, the most challenging things are the patchwork of global regulations, the need for clear definitions and harmonized standards like “recyclable” or “compostable” (by the definition of the local legal jurisdiction), and the immense reporting and transparency verification requirements. Regulatory bodies often require detailed documentation and may implement verification processes to substantiate claims related to a reduction in material amount used, PCR content, product reuse, recyclability, or composability. Businesses need to invest in ERP systems to establish robust data collection and extra tracking systems just for packaging to meet these reporting obligations. Also, technological innovations make this market very dynamic, so newly developed materials that can fall under eco-modulation bonuses need to be constantly monitored and implemented in stages when they are ready for upscaling. In times of economic uncertainty (tariffs, global conflicts) together with environmental changes which are reshaping supply chains, companies need to be very focused on choosing the right solutions which will enable the most sustainable solutions with minimal economic costs, including AI technologies.

## 5 REFERENCES

Bünemann, A., Brinkmann, J., Löhle, S. and Bartnik, S. (2020). EPR Toolbox | Know-how to enable Extended Producer Responsibility for packaging. [online] <https://prevent-waste.net/epr-toolbox/#factsheets>. Bonn: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH PREVENT Waste Alliance. Available at: [https://prevent-waste.net/wp-content/uploads/2024/03/PREVENT-Toolbox-interactivePDF\\_2024.pdf](https://prevent-waste.net/wp-content/uploads/2024/03/PREVENT-Toolbox-interactivePDF_2024.pdf) [Accessed 27 Aug. 2025].

Clarity. (2024). EU EPR for Packaging Rollouts: A State-by-State Guide | Clarity. [online] Available at: <https://clarity.eco/knowledge/a-state-by-state-guide-to-the-rollout-of-packaging-epr-approaches-across-eu-member-countries/>.

Daniela Michaelis (2025). The Evolution of EPR in the EU: From Waste Policy to Circular Economy Driver | 3E. [online] Available at: <https://www.3eco.com/article/the-evolution-of-epr-in-the-eu/>.

EU Commission (2016.). Eco-Emballages (France) | Green Best Practice Community. [online] Available at: <https://greenbestpractice.jrc.ec.europa.eu/node/193>.

Mitch Webster. (2024). Extended Producer Responsibility Laws for Packaging Around The World. [online] Available at: <https://packagingschool.com/lessons/extended-producer-responsibility-laws-for-packaging-around-the-world>.

OECD (2016). Extended Producer Responsibility - Guidance for efficient waste management. [online] OECD. Available at: <https://www.oecd.org/en/topics/extended-producer-responsibility-and-economic-instruments.html> [Accessed 27 Aug. 2025].

Piece, L. (2025). Extended Producer Responsibility (EPR) Eco-modulation Overview. [online] <https://sustainablepackaging.org/>. Sustainable Packaging Coalition i. Available at: <https://sustainablepackaging.org/wp-content/uploads/2025/04/SPC-Mini-EPR-Eco-Modulation-Final.pdf> [Accessed 27 Aug. 2025].

Pravin Kumar Mallick, Kim Bang Salling, Daniela C.A. Pigosso and McAloone, T.C. (2024). Designing and operationalising extended producer responsibility under the EU Green Deal. *Environmental challenges*, 16, pp.100977–100977. doi:<https://doi.org/10.1016/j.envc.2024.100977>.

Sayegh, C. (2025). Eco-Modulation & EPR: Lower Packaging Fees & Boost Sustainability | H2 Compliance. [online] H2 Compliance. Available at: <https://h2compliance.com/the-rise-of-eco-modulation-a-deep-dive-into-how-fees-are-driving-greener-packaging/> [Accessed 27 Aug. 2025].

UNEP (2022). Reducing Plastic Pollution through the Extended Producer Responsibility. [online] UNEP - UN Environment Programme. Available at: <https://www.unep.org/reducing-plastic-pollution-through-extended-producer-responsibility>.

Vana. (2025). Eco-modulated fees. [online] Available at: <https://www.vana.dk/en/producer-responsibility/eco-modulated-fees/> [Accessed 27 Aug. 2025]