RECYCLABLE IS NOT **RECYCLED.**

What the new PPWR debate reveals about structure design, sorting reality and packaging performance through a technical Mitsui Chemicals perspective.

INTRODUCTION

PPWR is reshaping the packaging debate – not by declaring one material right and another wrong, but by demanding evidence. The regulation introduces obligations across the entire packaging life cycle: recyclability, packaging minimisation, recycled content, reuse, labelling and conformity assessment. It raises the bar for what counts as a credible answer.

What it does not do is resolve the underlying tensions. It does not replace technical evaluation with political convenience. And it does not make the hard trade-offs disappear.

That is exactly where this whitepaper begins. Packaging does not function as a symbol. It functions as a structure. Real decisions are made in barrier requirements, layer builds and sorting realities.

For Mitsui, that is where the relevant technical contribution begins. Where multilayer structures, functional layers and demanding applications come together, the role of material technologies changes. Products such as ADMER™ stand for a precise technical question: how can performance, structural integrity and real system requirements be brought together reliably?

This whitepaper follows one simple but inconvenient insight: Recyclable is not the same as recycled. And visibly simple is not automatically structurally superior.

PPWR MILESTONES AT A GLANCE

As the packaging industry adapts to the new regulatory landscape, several key PPWR milestones will shape future packaging development, recyclability assessments and market access requirements.

11 February 2025

Regulation (EU) 2025/40 enters into force, twenty days after publication in the Official Journal. The PPWR establishes a harmonised regulatory framework for packaging and packaging waste across the EU, replacing the former Packaging and Packaging Waste Directive 94/62/EC.

12 August 2026

General application of PPWR requirements begins under Article 71, following an eighteen-month transition period. The majority of PPWR obligations become applicable, introducing sustainability, recyclability and compliance requirements across the packaging value chain.

1 January 2030

From 1 January 2030, packaging will need to meet the applicable design-for-recycling criteria and be assigned recyclability performance Grade A, B or C. Only packaging achieving Grade C or above fulfils the applicable recyclability performance requirements. Further requirements, including minimum recycled content, reuse targets, the empty space limit and certain format restrictions, have their own application dates and conditions under the PPWR.

1 January 2035

From 1 January 2035, the recycled-at-scale (RaS) assessment becomes part of the PPWR recyclability framework. Packaging must be designed for recycling and meet the applicable conditions for recycling at scale.

2038

From 1 January 2038, packaging will need to achieve recyclability Grade A or B for market placement. Grade C packaging will fall outside the requirements for market placement, further increasing pressure on packaging design and material selection.

RECYCLABLE IS NOT **ENOUGH**

If a packaging format is technically recyclable, what still prevents it from entering a real recycling loop?

Technical recyclability is a necessary starting point, but it is not reliable proof that a package will actually enter a functioning recycling pathway in practice. That distinction is frequently blurred in the current debate. As soon as something is called "recyclable," the impression arises that the core problem has already been solved.

Yet between material suitability and actual material recovery lies a long chain in which collection rates, sorting efficiency, fraction quality and economic recoverability play at least as important a role as the material itself. PPWR sharpens that perspective: regulatory pressure increases attention not only on packaging design, but on whether a structure has a credible future in a real system at all.

A polyethylene pouch illustrates exactly where that gap opens up:

A PE pouch may, depending on its specific structure and the applicable assessment criteria, meet design-for-recycling requirements because the main structure is compatible with PE recycling streams. However, if the format has low collection rates, poor sorting detectability or insufficient recycling infrastructure, actual recovery may remain limited. The structure may be recyclable in theory, though not necessarily becoming recycled material in practice.

Recyclable is a beginning. Recycled would be the proof.

LESS MATERIAL
IS NOT THE WHOLE ANSWER

Does reducing weight automatically improve packaging outcomes, or does it sometimes shift the problem elsewhere?

Reducing material input is often framed as a self-evident improvement. Less material appears to mean less burden. In practice, the picture is more complex. Packaging is not used because of weight alone. It protects products, secures processes, stabilises shelf life and meets logistical requirements.

This balance is also reflected in PPWR. Article 10 requires packaging minimisation while maintaining the functionality necessary for product protection, handling, transport, storage and presentation. The regulation does not treat weight reduction as an objective independent of performance.

The risk of getting that balance wrong becomes concrete when looking at industrial film applications:

A downgauged stretch hood or pallet shrink film can reduce polymer consumption per pallet. However, excessive thickness reduction may require higher application rates, create instability during transport, or increase product losses due to load failure. Material reduction only delivers environmental benefits if required packaging performance is maintained.

Weight is not a clean proxy for packaging quality. The real question is not how much material a package uses, but whether it delivers the performance its application demands under real conditions.

THE VISIBLE MATERIAL IS NOT THE **FULL STRUCTURE.**

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Why do packaging debates focus on the substrate, while performance and recyclability are decided by the complete structure behind it?

In public perception, packaging is often read through the visible substrate. Paper feels different from plastic, mono-material different from composite. Technically, that alone says surprisingly little. The actual performance of a package is rarely created by the substrate in isolation. It is created by the interaction of multiple functional layers, each carrying a different task.

This matters directly under PPWR. The regulation focuses on recyclability performance and applicable design-for-recycling criteria rather than prescribing mono-material packaging as a general requirement. Article 6 takes account of the packaging structure and its relevant components. A paper-based format that requires coatings, barriers or seal layers to function can therefore also involve a technically complex structure.

The visible substrate does not determine recyclability. The full structure does.

The following two cases show this from opposite directions. The first looks at what is lost when a structure is simplified for recyclability. The second looks at two packages that appear identical to the buyer, yet differ fundamentally in their build.

Case 1 – Flexible plastic: simplification has a price.

A mono-material PE stand-up pouch may be recycled more easily than a PET/PA/PE structure. However, for oxygen-sensitive products such as coffee, pet food, meat or cheese, the simplified structure may not achieve equivalent barrier performance, potentially affecting shelf life.

Case 2 – Paper-based packaging: the label hides the build.

Two packages may both appear to be paper-based. One may consist largely of fibre, while the other incorporates polymer coatings, barriers, sealants and adhesives that determine moisture resistance, heat sealability and processing performance. The visible substrate alone does not explain packaging functionality.

For Mitsui, this is a central point of entry: performance is not explained by a material label, but by the technical design of the full structure.

Packaging is not a surface. It is a system. And systems cannot be meaningfully judged through only one visible component.

DESIGN DECISIONS TRAVEL **DOWNSTREAM**

How do early structure choices influence sorting, recycling pathways and the practical fit of a packaging format later on?

Packaging development is not an isolated early phase. Decisions made in structure design continue to have effects far beyond conversion. Material combinations, layer builds, additives, colours, adhesives and compatibilities help determine how a package can later be identified, sorted, processed and recovered.

The PPWR recyclability framework takes account of elements such as labels, closures, sleeves, coatings, adhesives and other structural components where they are relevant to sorting and recycling performance. What looks like a design decision at the beginning can become a system decision at end of life.

A seemingly minor pigmentation choice shows how far that reach extends:

A dark-coloured HDPE bottle may satisfy product protection requirements during use. However, carbon-black pigmentation can reduce near-infrared detectability in some sorting systems, potentially affecting recovery efficiency at end of life. NIR-detectable black pigment systems are available and can, when appropriately specified, address this particular sorting challenge. They leave the underlying principle intact: a choice made for appearance or product protection can also affect sortability.

This is where the role of Mitsui products shifts, not as an add-on at the end, but as part of how structure design, material compatibility and functional requirements are brought together in early-stage development decisions.

Good structures emerge where performance and system fit are considered together from the start.

REGULATION DOES NOT REMOVE TRADE-OFFS
AND NEITHER DOES PERFORMANCE PRESSURE.

Does PPWR resolve packaging tensions, or does it make existing design conflicts more visible, more binding and harder to ignore?

In many debates, regulation is treated as the instrument that finally creates clarity. In practice, it often creates visibility first. PPWR brings several objectives together simultaneously – recyclability, packaging minimisation, recycled content requirements, reuse targets and documentation obligations. The resulting trade-offs do not disappear: they become more transparent and more consequential.

The same applies to performance. Under regulatory and public pressure, the temptation is growing to judge packaging primarily by its end-of-life. That view matters but it remains incomplete. Barrier, sealing, shelf life, processability and product protection remain hard criteria. A package that performs well on recyclability but fails on barrier is not a better package.

Both dimensions of this tension come together in the following example:

A packaging developer may simultaneously be required to reduce package weight, improve recyclability, increase recycled content, maintain shelf life and control costs. Improving one parameter often influences the others. A packaging format with excellent recyclability characteristics but inadequate oxygen barrier performance, for instance, may lead to increased food waste through reduced shelf life. Regulation creates the framework but does not eliminate the engineering trade-offs behind it.

Regulation does not replace a technical decision. It merely increases the consequences when that decision was thought through too simplistically.

COST PRESSURE
IS BECOMING A **DESIGN VARIABLE.**

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Will future packaging economics reflect real recyclability and system fit, or mainly simplified proxies such as weight and category?

Under the new regulatory framework, cost logic itself is increasingly becoming a design driver. The PPWR introduces provisions linking Extended Producer Responsibility fee modulation to packaging recyclability performance. As a result, packaging structures may increasingly experience financial advantages or disadvantages depending on how well they fit future recycling systems. Cost thus becomes a design variable with both financial and technical dimensions, one that can already influence development decisions.

The open question is how precisely such models can reflect actual recoverability. Do they truly capture waste-stream quality, system fit and functional differences – or do they once again create rough proxy logics based on weight, category or simplified design features? If economic signals are too imprecise, they will still influence packaging development, but not necessarily in the right direction.

The following case shows where that gap between cost logic and system reality becomes commercially relevant:

Two packaging formats may deliver comparable product protection. If one receives a more favourable recyclability assessment within future eco-modulated EPR schemes, the total system cost may differ significantly despite similar manufacturing costs.

Cost thus becomes a design variable that acts not only financially, but technically as well – and that shift is already shaping development decisions today.

THE INVISIBLE LAYER IS BECOMING **MORE VISIBLE.**

As packaging structures come under closer scrutiny, what role do functional layers and bonding technologies play in future-ready design?

The more closely packaging structures are examined from both regulatory and technical perspectives, the more attention shifts toward those components that have long remained invisible in public perception. Functional layers, adhesion promoters, compatibility logics and the integrity of the full layer build often determine whether a package can function robustly at all. They are often the condition that allows protection, processing and structural performance to come together in the first place.

As recyclability assessment becomes increasingly structure-oriented under PPWR, the influence of these less visible elements on collection, sorting and recycling outcomes will receive greater technical scrutiny than in the past.

This is where the precise Mitsui moment of this whitepaper lies. Products such as ADMER™ stand for exactly this often-overlooked level of structure design. The question of how adhesion, compatibility and functional integrity can be created reliably within multilayer packaging.

A multilayer structure combining polyethylene and EVOH makes this role tangible:

In a multilayer structure combining polyethylene and EVOH, the consumer may only see the outer package. However, the adhesion technology between the layers often determines whether the structure can function reliably throughout production, filling, transport and use – and how it behaves within downstream sorting and recycling processes.

The invisible layer becomes more visible as soon as the discussion becomes more technical. And that shift is already underway under PPWR.

CONCLUSION

The current PPWR debate is reshaping the packaging world not because everything is suddenly new – but because it no longer leaves existing trade-offs in the background. What was often treated as a technical detail is now becoming visible in regulatory terms, more relevant economically, and more strategically charged.

The regulation does not establish a universally preferred material. Instead, it increasingly focuses on demonstrable performance across recyclability, resource efficiency, functionality and system compatibility. Anyone who takes that reality seriously has to move away from symbolic simplifications and toward technically robust evaluation.

From Mitsui's perspective, that is exactly where the decisive contribution lies – not in loud claims, but in a precise perspective on structure design, functional layers, compatibility and performance under real application conditions. The more packaging is discussed in terms of real function, system fit and technical integrity, the more visible the value becomes of those layers that have long remained invisible in public debate.

Recyclable is not recycled. And packaging is not future-ready because it looks simple. It is future-ready because its structure holds up under real conditions.

WHAT THIS MEANS
FOR YOUR DEVELOPMENT WORK

Five questions worth asking before your next structure decision:

1. Ask for recycling evidence, not recyclability claims. Request data on collection, sorting detectability and actual recovery for your specific format, going beyond a design-for-recycling assessment alone. Under the PPWR's 2035 recycled-at-scale framework, this second question becomes increasingly relevant to future market access.

2. Define your performance floor before you optimise weight or structure. Fix the barrier, sealing and shelf-life values your application genuinely requires, and treat them as boundary conditions. Optimisation without a defined floor shifts risk into logistics, product loss and food waste rather than removing it.

3. Assess the full structure, not the substrate. Document every functional layer, coating, adhesive and additive in your build including in paper-based formats. Recyclability grading under PPWR will follow the complete structure, and a fibre-based package with polymer functionality is not automatically the simpler case.

4. Screen design choices for downstream effects early. Check pigments, labels, sleeves, closures and adhesives against sorting and recycling behaviour during development, not after qualification. Late-stage changes to a validated structure are the most expensive kind.

5. Model eco-modulated EPR costs as part of the business case. Include projected fee differentials in structure comparisons. Two formats with identical manufacturing costs can diverge significantly in total system cost. That difference is becoming a design argument, not just a finance one.

None of these questions has a single correct answer. They are the questions that make the trade-offs visible early enough to decide them deliberately. That is where a technical materials partner becomes useful before the structure is fixed, not after.