

Material Substitution (ESG): Sustainable Material Alternatives in Procurement Management

In an ESG context, material substitution refers to the planned replacement of materials and components with alternatives that have a better sustainability profile. For technical buyers, this combines the classic task of materials management with carbon footprint, supply chain due diligence and regulatory evidence obligations. Anyone who approaches substitution strategically not only lowers emissions but also reduces dependencies on critical raw materials.

Key facts

- Material substitution is the targeted replacement of materials with more sustainable or more readily available alternatives.
- Typical drivers are CSRD reporting obligations, CO2 targets, supply chain laws and raw material risks.
- Substitution decisions require technical approvals such as First Article Inspection (FAI) and re-evaluation in supplier performance evaluation.
- In practice, the effort shifts from price comparison to data collection: life cycle assessments, provenance evidence and material data.
- An ABC analysis helps to focus substitution projects on high-value and high-risk materials.

Definition: Material Substitution (ESG)

Material substitution in an ESG context is the systematic replacement of materials, alloys, plastics or semi-finished products with alternatives that are rated more favourably from an environmental, social and governance perspective. The term covers both complete material changes and partial replacements, for example the use of secondary raw materials.

Distinction from classical substitution

Classically, substitution primarily served security of supply, for example in shortage part management when a product failed. The ESG-driven variant is preventive and strategic: it asks primarily about carbon footprint, recyclability, provenance risks and compliance, and secondarily about price and availability. The two perspectives complement each other, because sustainable alternatives are often also less dependent on raw materials.

Regulatory framework

Key drivers are supply chain laws, the battery regulation for product base materials, ecodesign requirements and sustainability reporting under the CSRD. Which obligations apply in each individual case depends on size, industry and supply chain and should be examined legally on a case-by-case basis. Material substitution thus turns from a purely technical project into a compliance measure with

reporting relevance.

Methods and approach in substitution planning

Successful substitution follows a structured process: inventory, prioritisation, technical evaluation, supplier development and release. The effort is rarely worthwhile for every C-part, which is why the right prioritisation determines efficiency.

Prioritisation with ABC analysis and risk assessment

The starting point is an ABC analysis of procurement volume combined with a material risk assessment: critical raw materials, high CO2 share, strong price volatility or problematic provenance. Typically, 80 per cent of the leverage volume is concentrated in a few material families such as aluminium, steel, plastics or electronic components. These clusters are addressed first.

Technical evaluation and release

Every alternative must be tested for mechanical, thermal, chemical and process suitability. Sample builds, endurance testing and a First Article Inspection (FAI) before release for series production are standard practice. Changes to drawings and bills of materials run through the engineering change process, so that materials management automatically plans with the new alternative in future.

Anchoring on the supplier side

Substitution only succeeds with the suppliers: existing sources of supply are asked about alternative materials, and new sources are identified through a structured enquiry. In addition, supply chain mapping provides transparency about upstream stages in order to make risks such as problematic mining conditions or intransparency among intermediaries visible.

Key KPIs for steering material substitution

Substitution projects need measurable targets, otherwise they remain declarations of intent. A small set of metrics covering environmental impact, cost and availability, maintained per material family, has proven its worth.

Environmental metrics

The key metric is CO2 savings per unit, derived from suppliers' life cycle assessment data. In addition, the share of secondary material, recyclability and water consumption per unit of weight are tracked. Data quality is often the bottleneck here, which is why a structured build-up of supplier documentation up to a golden record for material master data is recommended.

Cost and availability

Alongside the purchase price, total cost of ownership matters: changes in the tooling procurement environment, modified machining parameters or different packaging sizes can significantly reduce the savings. In parallel, procurement risk and the number of alternative sources are monitored, as substitution frequently also improves supply resilience.

Risks and controls in the substitution process

Material changes carry technical, commercial and legal risks. Addressing these early avoids expensive

recalls or supply blocks.

Technical and quality risks

Replacement materials often behave differently in the process: different heat treatment, different shrinkage values, differing corrosion properties. Controls include sample testing, extended incoming goods inspections and a temporary period of enhanced incoming inspection. Supplier performance evaluation should be extended to include sustainability criteria so that substitution targets reach supplier management.

Contractual and legal safeguards

Changed material specifications affect warranty, limitation of liability and product liability, especially for safety-critical components. Warranties regarding the material should be clearly formulated in the framework agreement. Special care applies to replacement purchases under failure conditions, for example via the spot purchase process, to prevent non-approved materials from entering series production.

Compliance and transparency

Provenance evidence, declarations of conformity and chemical information must be provided by the supplier and be audit-proof. A functioning whistleblower system can uncover indications of grievances in the upstream supply chain. Ideally, the reporting data flows into structures compatible with the GRI Standards to avoid duplication in sustainability reporting.

Current developments: digitalisation and raw material dynamics

Material substitution is becoming increasingly data-driven and dynamically steered. Price and availability signals flow into development decisions earlier.

Data-based material evaluation

Material databases with life cycle assessment and compliance attributes are gradually replacing Excel lists. In procurement data exchange via standards such as cXML, material and certificate information can be managed with greater automation. What remains important is that master data are properly maintained, otherwise intransparency arises instead of verifiability.

Secondary raw materials and the circular economy

Recyclates and secondary metals are gaining importance, driven by regulatory recycle quotas and customer demand. Challenges are quality consistency and plannable availability; close forecast sharing with suppliers helps here, whereby forecast errors can affect the quality and availability of recycle streams.

Integration into planning processes

Substitution decisions are shifting into detailed procurement capacity planning and product development: those who substitute early avoid expensive conversions later. In practice, material roadmaps are becoming established which, per component class, map target materials, transition periods and release status.

Typical metrics

CO2 savings per material family: typically 10–40 % per substituted item

Dependent on suppliers' life cycle assessment data

Proportion of approved sustainable alternatives: > 70 % of prioritised items

Target value after the first substitution wave

First-pass quality rate after substitution: > 98 %

After FAI and enhanced incoming inspection

Alternative sources per substituted material: at least 2

Reduces procurement risk and price dependency

Practical example

A medium-sized mechanical engineering company with around 400 employees found that a large share of its Scope 3 emissions came from three steel families and one semi-finished plastic. After prioritisation via ABC analysis, alternatives with a higher secondary share were qualified for the highest-value items.

- Material risk and CO2 review across the ABC analysis classes, focusing on five material families
- Technical qualification via sample builds and First Article Inspection (FAI) with revised drawing release
- Supplier workshops for data collection and extension of supplier performance evaluation to include ESG criteria
- Contractual adaptation of specifications including review of limitation of liability and warranties

Conclusion

Material substitution (ESG) combines classical procurement management with sustainability requirements and raw material security. Success depends less on individual material decisions than on a robust process: prioritisation, technical release, supplier involvement and legal safeguards. Those who consistently measure KPIs make progress reportable and arguable. In view of growing regulatory requirements, substitution is turning from a one-off project into a permanent discipline. Buyers who fill this role early secure cost, security of supply and compliance all at once.

Frequently asked questions

What does material substitution mean in an ESG context?

Material substitution refers to the planned replacement of materials with alternatives that have a better environmental, social and governance profile. The focus is on CO2 savings, recyclability and low-risk provenance. What distinguishes it from a purely technical material change is its link to sustainability reporting and supply chain due diligence.

Which materials are frequently substituted?

In practice, substitution projects mainly concern aluminium and steel with a high primary share, engineering plastics versus biopolymers or recyclates, and conflict minerals in electronics. Packaging and insulation materials are also frequent objects of substitution. The selection should be based on volume and risk analysis, not on isolated initiatives.

How does material substitution proceed in procurement?

There are typically six steps: inventory of materials, prioritisation by volume and risk, market search for alternatives, technical qualification including sample testing, contractual and drawing release, and transfer into series procurement. In parallel, master data and compliance evidence are updated. Depending on safety relevance, the cycle typically takes several months.

What are the risks of material substitution?

The main risks are unexpected behaviour in the manufacturing process, shortened service life, quality consistency of the new supplier and market availability of the alternative. Legally relevant are warranties, guarantee claims and product liability for safety-critical parts. Controls such as sample testing, enhanced incoming inspection and clear specifications significantly mitigate these risks.

What does material substitution cost?

The costs comprise development and testing effort, sample costs, modification effort in the tooling and process environment, and possible price premiums for the alternative. The material price of the alternative is often higher, while total cost of ownership is offset by lower raw material risks and lower CO2 costs. A total cost analysis is therefore essential.

Is material substitution mandatory under the law?

There is no general obligation to substitute materials. However, legal frameworks such as ecodesign requirements, recycle quotas for certain product groups and sustainability reporting create indirect pressure. Which obligations apply in a specific case depends on product, industry and company size and should be examined legally on a case-by-case basis.