TOWARDS A
# LOWER CARBON EMISSION POWDER COATINGS VALUE CHAIN

## An industry case study in Building & Construction applications

A value chain collaboration to lower carbon emission of powder coatings by

AkzoNobel ARKEMA BASF We create chemistry

# Towards a lower carbon emission powder coatings value chain

Among the various industrial coating technologies, **powder coatings represent a more sustainable alternative** to conventional surface finishes – while still delivering the durability required for architectural applications.

As sustainability becomes a central focus in construction projects, powder coatings are increasingly aligned with evolving industry priorities. **They are free from Volatile Organic Compounds (VOCs)**, generate no hazardous waste, and any over-sprayed powder can be reclaimed and reused.

**This publication aims to demonstrate how the powder coatings value chain can contribute further reducing carbon emissions.**

## Collaborating for a more sustainable future

In this industry case study, **AkzoNobel**, **Arkema**, and **BASF** have joined forces to introduce a lifecycle approach for developing more sustainable powder coatings for architectural applications.

This collaborative effort aims to set a new market standard for a lower-carbon footprint product portfolio.

In addition to outlining the operational steps taken to develop this new low-carbon value proposition, we also provide insights into the key methodologies used to successfully transform AkzoNobel's architectural powder coatings portfolio.

## Leading by example to drive value chain transformation

At a time when few roadmaps exist how to actively drive sustainability transformation across complex value chains, we recognize our responsibility **not just to act, but to lead by example**.

By sharing progress made within the powder coatings industry, we aim to **inspire and empower others** throughout the value chain.

**True impact can only be achieved through collective action – and only together can we enable the systemic change needed for a more sustainable future.**

CASE STUDY OUTLINE

01

***Key Building & Construction drivers* to reduce greenhouse gas emissions**

02

**Key steps for a *reduced carbon emission* powder coatings value chain**

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**A practical powder coatings *case study***

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Next steps: advancing toward ***a net-zero powder coating*** value chain

**01**

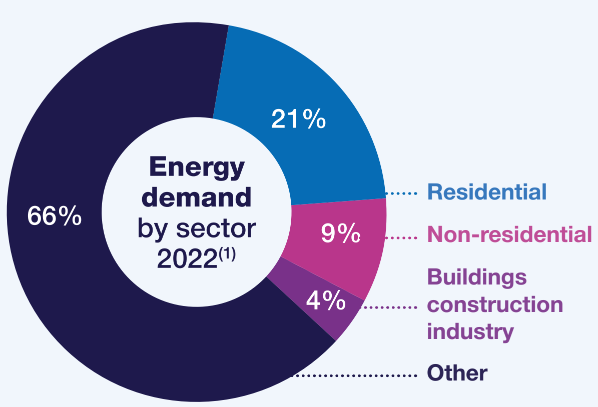
# ***Key Building & Construction drivers*** to reduce greenhouse gas emissions

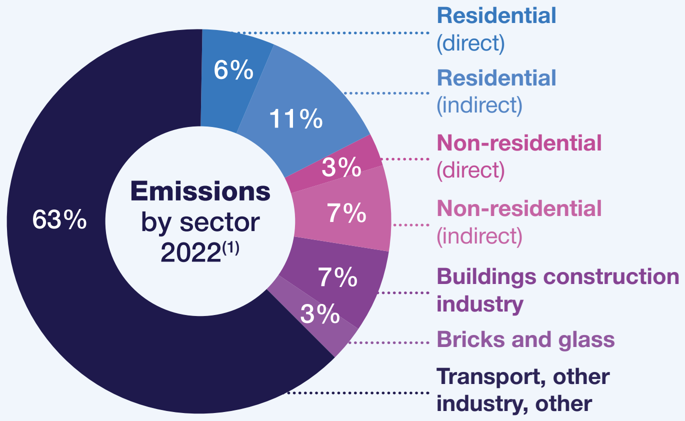
## The role of coatings in creating sustainable buildings

The built environment sector contributes significantly to global carbon emissions, accounting for 37%[1] of energy-related carbon emissions with embodied and operational carbon. With the global floor area of buildings expected to double by 2060, the urgency to lower the $CO_2$ emission impact of this sector is paramount. The growth in new buildings, particularly in Asia and Africa, and the challenge of upgrading Europe's aging building stock, underscore the need for **more sustainable construction practices.**

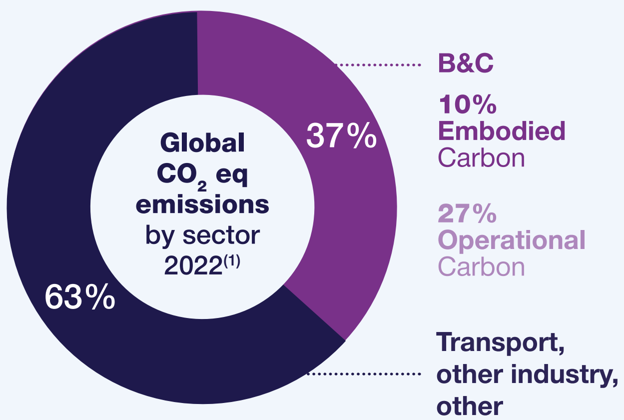
Building & construction is one of the biggest end markets for the paints and coatings industry, with approximately 60%[2] of the volume. It is therefore key to understand how the coatings industry can contribute to lower embodied and operational carbon. In addition, **coatings play a key role in sustainability**, as their primary function goes **beyond aesthetics:** they **protect surfaces, extend the lifespan of the substrate, and contribute to the durability of the entire building.**

## 1 The importance of reducing global carbon emissions in Building & Construction

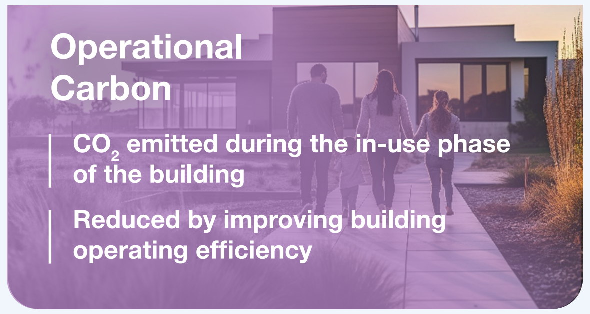



A building's carbon footprint is a combination of embodied and operational carbon. **Embodied carbon** is related to $CO_2$ emissions associated with the **entire lifecycle of materials** used in building construction, from extraction and manufacturing to transportation, installation, maintenance, and disposal. On the other hand, **operational carbon** refers to the emissions produced during the **use phase of a building**, primarily from energy consumption for heating, cooling, lighting, and appliances. While operational carbon emissions can be minimized with energy-efficient practices and renewable energy, **embodied carbon is permanently locked into the structure** once construction is complete. Accounting for approximatively 1/3 of the overall emissions of the Building & Construction sector, embodied carbon is projected to grow to nearly half of new construction's carbon footprint by 2050[2], in a business-as-usual scenario.







## 2 Regulatory and market drivers

A key aspect of more **sustainable construction** consists of lowering both operational and embodied carbon footprints. As operational carbon of buildings grows more slowly[3] — driven largely by energy efficiency measures and economic incentives — a new focus has been given on the reduction of embodied carbon. In response, there has been an **increased number of key initiatives** pushing the Building & Construction ecosystem **to address the embodied carbon:**

> Green deal and mandatory regulations: Initiatives like the European Green Deal, carbon taxation, and emissions trading systems (ETS) are setting stringent targets for reducing carbon emissions.

> Voluntary Certifications: Green building certifications such as LEED, BREEAM, and WELL promote sustainable building practices by encouraging to meet specific environmental standards.

> Corporate Sustainability Reporting Directive: Companies are increasingly setting science-based targets to reduce greenhouse gas emissions, focusing on ending the use of fossil fuels, cutting operational emissions, and lowering embodied carbon.

In addition to these key initiatives, it is essential to acknowledge the continued relevance of energy cost as a structural and long-standing driver. Despite the growing focus on climate goals, the rising and volatile cost of energy remains a powerful motivator for both manufacturers and end-users to adopt lower-carbon, energy-efficient, low carbon footprint solutions.


## 3 Towards net-zero metal

As a consequence, the largest **carbon emitters** (metals, concrete) are reacting and now **offering lower-carbon footprint materials.** Among those materials, aluminium is a key enabler for this transition. By essence, **aluminium is a circular material**, capable of being recycled over-and-over again without losing its original properties (lightness, conductivity, formability, durability, permeability and infinite recyclability). Leveraging renewable energy like hydropower and hyper-efficient electrolysis technology at aluminium smelters can reduce the carbon footprint to 4 kg $CO_2$[4] per kg of aluminium[5]. This represents a significant improvement compared to the 8.46 kg $CO_2$ per kg of mill-finished aluminium[6] reported in a cradle-to-gate study by Institut Bauen und Umwelt.

Although the carbon footprint of coatings on aluminium substrates is relatively small compared to that of aluminium itself, the growing efforts to reduce greenhouse gas emissions in the aluminium industry are now shifting attention towards the coatings sector as well. Hence, **coating carbon emissions are gaining attention**, alongside efforts to extend product lifetime. It can be considered that the longer building materials last, the less waste they generate — and the lower energy and chemicals are required for repair and maintenance or replacement. In short, improving material durability can contribute to reduce both environmental impact and use of resources over time.

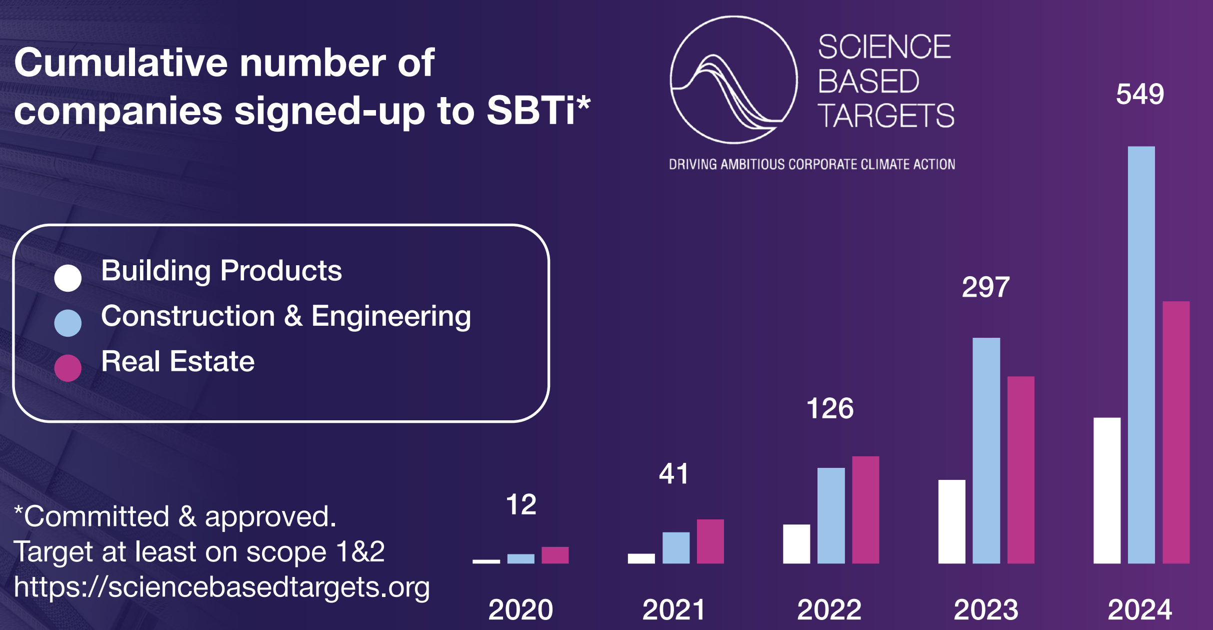
### Durability of coatings to extend lifespan of substrates

Even if the durability of the coating is not considered as a further benefit in EPDs[14], it is key to highlight this which contributes twice to reduce the carbon footprint of an aluminium coated part in:

> The need for maintenance and recoating is reduced so there is less powder use during lifetime of the part. Also, simply building surfaces which are more durable require less cleaning.

> The aluminium part benefits from an extended lifespan and thus contributes to limit the extraction of bauxite or the need for recycling.

### Cumulative number of companies signed-up to SBTi*




*Committed & approved.
Target at least on scope 1&2
https://sciencebasedtargets.org

02

# Key steps for a ***reduced carbon emission*** powder coatings value chain

## Powder coatings and Building & Construction industry

Powder coatings have several key benefits across environmental, performance and economic dimensions which is why they become highly popular in many industrial applications. Performance benefits of durability and corrosion resistance meet with high-quality aesthetics offering wide range of colors and finishes. These combined advantages make **powder coatings the preferred choice for many building & construction applications**, such as on architectural facades, window frames, doors, or cladding systems.

With sustainability becoming a core consideration in construction projects, powder coatings as a **surface finish for aluminium** align with industries' evolving priorities through no VOCs, high material utilization due to high transfer efficiency and **minimized waste application process**. As carbon emission optimized aluminium is now available, minimizing the environmental impact of powder coatings becomes increasingly important.

## 1 Identify carbon emission hotspots through entire value chain

A key task for each complex value chain collaboration targeting lower carbon footprint claims is to **establish a common understanding of carbon emission hotspots** by gathering **supplier specific environmental impact** of the different products used. In the Building & Construction sector, three main trusted tools are used: Life Cycle Assessment (LCA), Environmental Product Declaration (EPD), and Product Carbon Footprint (PCF). These elements are interconnected and build upon one another.

An LCA is a broader and more comprehensive tool. It assesses multiple environmental impacts — not only carbon emissions — across all life cycle stages. This includes indicators like water use, energy consumption, and pollution. The PCF is one of the outcomes of an LCA, focused on climate change (global warming potential).

An EPD is a standardized, third-party verified document that summarizes the results of an LCA, including the PCF. It follows international standards (such as ISO 14025, ISO 21930 and EN 15804) and is widely used in the Building & Construction sector to provide transparent and comparable information on a product's environmental performance. EPDs are often required for green building certifications like LEED or BREEAM.

A PCF measures the total greenhouse gas emissions associated with a product throughout its life cycle — from raw material extraction to factory gate, or even to end-of-life. It focuses specifically on climate impact, expressed in kg $CO_2$ equivalents per kg of product.

All these tools are useful to establish an **accurate point of reference**, which is essential to ensure reliable tracking and meaningful reduction efforts. To do so, it is important to define a **standardized and verifiable methodology of PCF calculation.** Thus, the “Together for Sustainability“ (TfS)[7] initiative sets common rules for PCF calculation allowing better comparability and transparency across stakeholders of the chemical sector.

When analyzing the carbon footprint across the entire powder coatings value chain, **two main $CO_2$ emission hotspots** clearly emerge.

> The biggest single driver (43%*) for $CO_2$ emission input in the powder coating value chain are **raw materials**.

> The second major contributor (41%*) is the **powder application phase**, specifically the curing stage on the applicator’s production line.

**AkzoNobel powder coatings value chain*

## 2 Supplier engagement and inclusion as key success criteria

**To successfully transition the powder coatings value chain** towards circularity and lower-carbon emission solutions, strong supplier engagement and collaboration is essential. For this collaboration, **AkzoNobel, Arkema and BASF shared the same mindset**, focusing on transparency, common standards, and aligned goals. A specific focus has to be directed towards cost to ensure that the final product remains affordable. In other words, the value chain must balance environmental impact with economic feasibility.

The underlying theme of this collaboration has been to enable an **open and inclusive approach**. The parties share the opinion that a real transformation towards more sustainable products can only be achieved by establishing credible supply alternatives at each step of the value chain.

Finally, this shared commitment has enabled AkzoNobel to develop a strong and resilient transformation roadmap for architectural powder coatings, aligned with its corporate sustainability goals and the specific requirements of the industry.

**Distribution of $CO_2$ Emissions in the AkzoNobel Powder Coatings Value Chain**

| $CO_2$ Upstream Emissions | | $CO_2$ Downstream Emissions | |
|---|---|---|---|
| 43% | 1% | 41% | 15% |
| **Powder suppliers** Scope 3 | **AkzoNobel** Scope 1+2 | **Powder customers** Scope 3 | **Powder end-of-life** Scope 3 |



## 3 Set the right target for your sustainability value proposition

Setting the right target for the sustainability value proposition requires a **careful balance between ambition and feasibility.** First and the foremost, sustainability value proposition must address a relevant and clearly identified need of the customer or the industry — whether driven by **regulatory pressure, sustainability commitments, or performance expectations.** The process must go beyond technical performance and consider multiple strategic dimensions.

**Affordability is key**: the product must deliver environmental benefits without compromising cost-effectiveness for customers. Competitive positioning helps to define a PCF reduction target that clearly differentiates the offer in the market.

At the same time, the targeted $CO_2$ advantaged solution must be scalable, ensuring it can meet growing demand across geographies and applications. To achieve cross-value-chain supply reliability, it is essential to secure long-term access to low-carbon footprint raw materials through supplier engagement.

Finally, the new sustainable product concept has to support the long-term build-up of a portfolio with an optimized carbon footprint, allowing product properties to evolve across generations while continuously enhancing sustainability performance.

# 03

# A practical powder coatings *case study*

AkzoNobel, Arkema and BASF have set up a value chain partnership for a **lower carbon footprint of AkzoNobel's Interpon D superdurable[8] powder coatings** – offering to meet industry standards like Qualicoat Class-2 and GSB Florida 3. Thanks to its extended durability properties offering 20 to 40 years of design life (coating comprises a protective layer), this range of powder coatings is particularly suitable for architectural sector applications, such as building facades, window/doors, and cladding panels.

## Hotspot #1

## Raw materials' carbon footprint

As explained previously, the main contributors to the cradle-to-gate PCF of powder coatings are raw materials, particularly the resin and titanium dioxide ($TiO_2$) used in the formulation.

This is why AkzoNobel, Arkema, and BASF have prioritized a **lower carbon footprint of superdurable polyester resins as a first step.**

The three companies have identified two key levers to improve the Product Carbon Footprint (PCF) of their products: the use of **supplier-specific Product Carbon Footprint (PCF) data** and the **bio attribution of renewable raw materials** to the polyester powder resins with the credit mass balance approach.

### 1st lever: using supplier-specific data

For this industry case study, the three partners have chosen to rely as much as possible on **supplier-specific data**. This approach acknowledges the investments made by suppliers to improve process and material efficiency, reduce energy consumption, and transition to renewable electricity — all contributing to a lower carbon footprint. Hence, while accessing comprehensive data across the entire value chain remains challenging, this approach offers **greater accuracy** in carbon footprint calculations enabling better sourcing choices. Accessing this set of accurate data is only possible by working with committed and reliable partners — those willing to collect, calculate, and share PCF data across the value chain.

To ensure consistency, supplier-specific PCF values must comply with international standards (ISO 14067, ISO 14040, ISO 14044) and TfS guidelines (v3, December 2024). Logically, these values may be higher or lower than industry averages. Over time, the quality of data in generic databases for specific raw materials is expected to improve with more specific data being used. In this study, the PCF values for both polyester resins and final powder coatings were calculated using supplier specific data of the three partners and compared against generic industry averages of the latest version of CEPE V4.0 database released in June 2024. This industry database is widely used in the paints and coatings industry to generate LCAs, EPDs and PCFs.

Hence, in this case study, **supplier-specific PCF data were transparently shared across the value chain.** Compared to PCF calculated with generic CEPE V4.0 database values:

> Polyester resin-related emissions are lower by over 52%

> The Interpon D range of superdurable powders showed up to 35% lower PCF

### $CO_2$ reduction lever selection

There are various levers for $CO_2$ reduction at hand along the powder coating value chain. However, each $CO_2$ reduction lever has an individual availability and cost profile – not all levers are readily available, not all are affordable yet. Their selection requires a clear understanding of downstream targets for PCF reduction, affordability, and availability.

To evaluate the affordability of a $CO_2$ reduction lever, the $CO_2$ abatement cost perspective provides a suitable parameter:

$$CO_2 \text{ abatement cost} = \frac{\text{cost (€ or USD)}}{\text{ton of } CO_2 \text{ saved}}$$

Typically, renewable electricity and dedicated supplier sourcing strategies can provide first low-cost options for $CO_2$ reduction. However, their overall PCF reduction potential is limited and further levers, e.g. bio feedstocks and biofuels, need to be activated to achieve ambitious PCF reduction targets.

**2nd lever: integration of bio-attributed polyester resin**

To further reduce the environmental impact of their products, AkzoNobel, Arkema, and BASF have leveraged a second key lever: the **accounting of biogenic uptake of $CO_2$ achieved via bio-attribution of renewable raw materials using the mass balance approach.**

After evaluating several reduction pathways, the partners decided to focus on **neopentyl glycol (NPG)**, a major monomer employed in the polyester resin production. NPG is available by BASF in a ZeroPCF[9] variant, has a broad availability via the mass balance approach, and thereby leverages a significant $CO_2$ reduction potential in powder coating polyester resins.

1 At the top of value chain, BASF has significantly reduced the PCF of its NPG by developing a bio-attributed[10], ISCC PLUS certified version, using renewable biomass feedstock. These renewable biomass feedstocks are either based on cover crops or biological waste-and residues. With the use of the renewable feedstocks and renewable electricity for its NPG ZeroPCF[9] product, **BASF has brought the PCF of its NPG down to zero.**

2 Next in the value chain, **Arkema has partially replaced the NPG used in the formulation of its Reafree® polyester resins** by BASF's NPG ZeroPCF[9]. The decision to only replace a share of NPG by bio-attributed NPG was made to maintain affordability, but the ratio can further be increased in the future. Once formulated, Reafree® polyester resins, which are ISCC PLUS certified, is supplied to AkzoNobel with a bio-attributed content of 20% on average. It results in a **PCF reduction of up to 6%[11], for the polyester resin**, by referring to data from CEPE V4.0.

3 Finally, for AkzoNobel, the use of biomass balance resins from Arkema in **Interpon D range superdurable powders has demonstrated up to 5%[12] product carbon footprint reduction** compared to previous products designed with standard non-bio-attributed resins with generic database PCF values based on CEPE V4.0.

**Result: up to 40%[11] PCF savings on final powder coatings**

As a result, the combination of supplier-specific PCF data and biomass balance along the value chain lead to a significantly lower carbon footprint of the powder coatings.

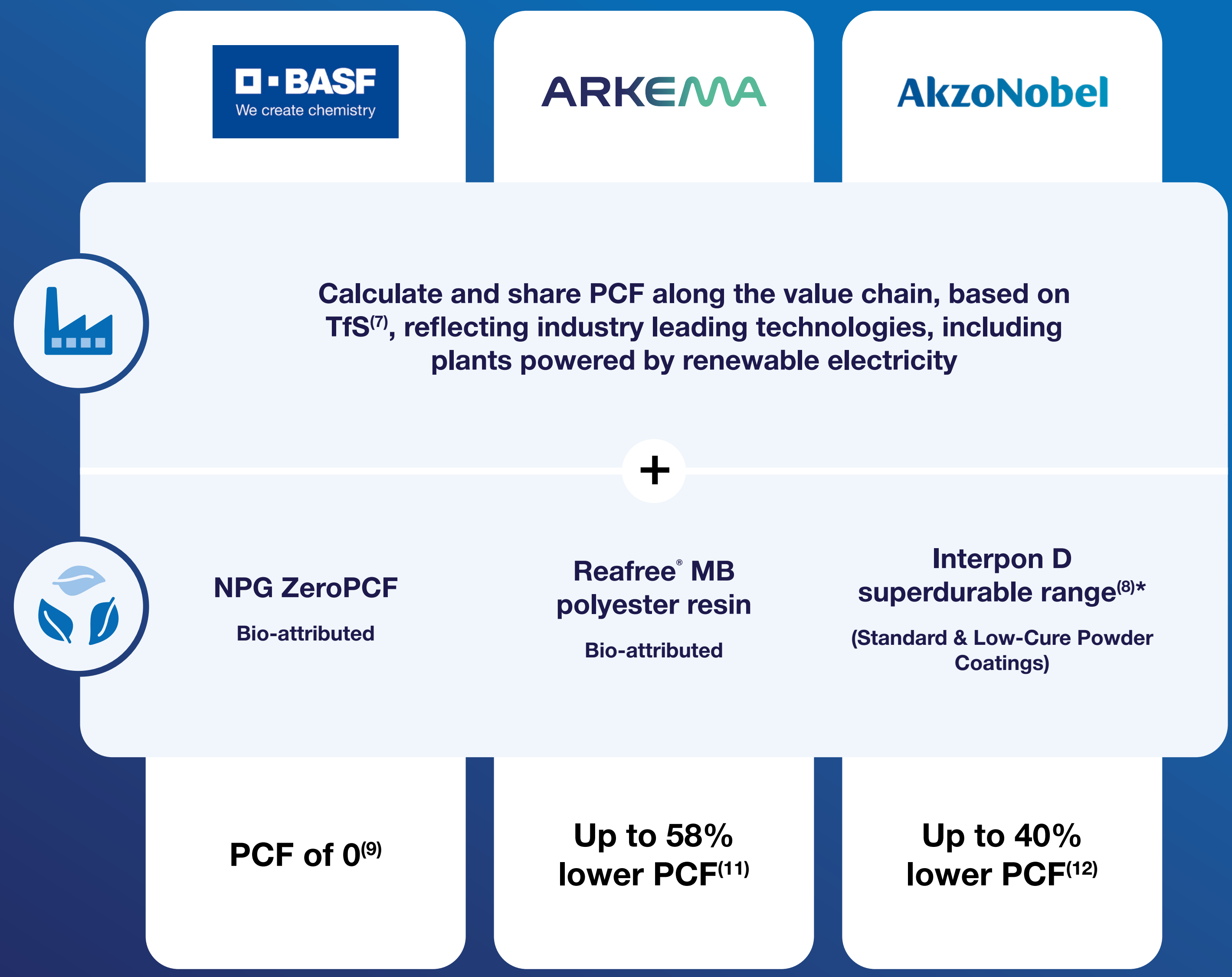
> BASF achieved a PCF of zero for its NPG (NPG ZeroPCF[9]) relying on bio-attribution via mass balance and the use of renewable electricity.

> Arkema's Reafree® solid polyester resin, thanks to supplier-specific and biomass-balanced NPG, shows a PCF which is up to 58%[11] lower compared to CEPE V4 industry averages for polyester resins.

> AkzoNobel's Interpon D range of super-durable powders, using supplier-specific and biomass-balanced resins, achieved up to 40%[12] lower PCF than CEPE V4 benchmark values.



## PCF savings in the powder coatings value chain

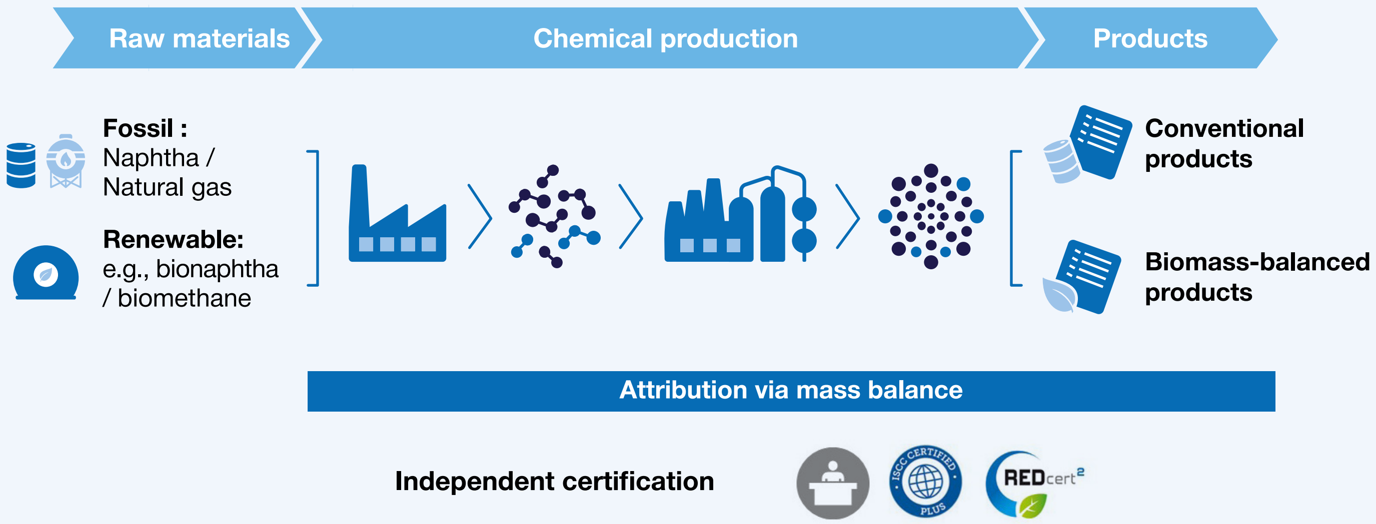



*in Europe

### Mass balance

The mass balance concept consists in **substituting fossil resources with renewable or recycled feedstocks in existing production processes,** without compromising product quality or performance. Mass balance relies on a chain of custody model, allowing the simultaneous use of alternative and conventional feedstocks in existing production systems. Although they cannot be physically distinguished in the final product, the **renewable share can be allocated to specific products or batches through verified calculations.** Independent certification schemes like ISCC PLUS or REDcert² ensure the traceability, proper replacement of fossil inputs, and correct attribution.

This approach preserves the economy of scale of existing chemical production assets and avoids additional investment costs for dedicated production lines. It also **significantly reduces greenhouse gas emissions**, supporting the commitment of companies to limit their environmental impact.




### Mass balance and renewable feedstocks

Renewable biomass feedstocks which enable meaningful PCF reductions are either based on **cover crops including silphium perfoliatum, tall wheat grass, ray grass, mustard, and others or based on biological waste-and residues like sewage sludge**. Cover crops are explicitly planted to fertilize and protect the soil between harvests and are thus not primarily planted to generate food. These biomass feedstocks are then **processed into renewable chemical feedstocks**, such as bio-methane, bio-naphtha, renewable diesel, or bio-methanol, which are then **blended with fossil inputs in existing chemical production systems**, without altering processes or product quality. The mass balance approach enables the gradual substitution of fossil resources with renewable feedstocks. Energy crops like corn, maize, sugar cane or rapeseed, which are in direct competition to food usage, are not used as biomass balance feedstocks in this use case.



## Hotspot #2
## Curing phase

As seen before, when evaluating the full cradle-to-grave carbon footprint of the powder coatings value chain, raw materials upstream contribution — mainly those provided by powder coatings suppliers — emerge as the largest $CO_2$ emissions hotspot, representing 43% of the total footprint. The next major contributor is the **powder application phase**, accounting for 41%, largely due to energy-intensive curing process, where the coated substrate is typically heated to 180 to 200°C.

To address this, **Arkema has developed a new range of low-cure polyester resins**. The Reafree® low cure technology is based on an advanced molecular design of the polyester resin, enabling efficient crosslinking at lower temperatures, without compromising on coating performance including weathering, corrosion and mechanical properties.

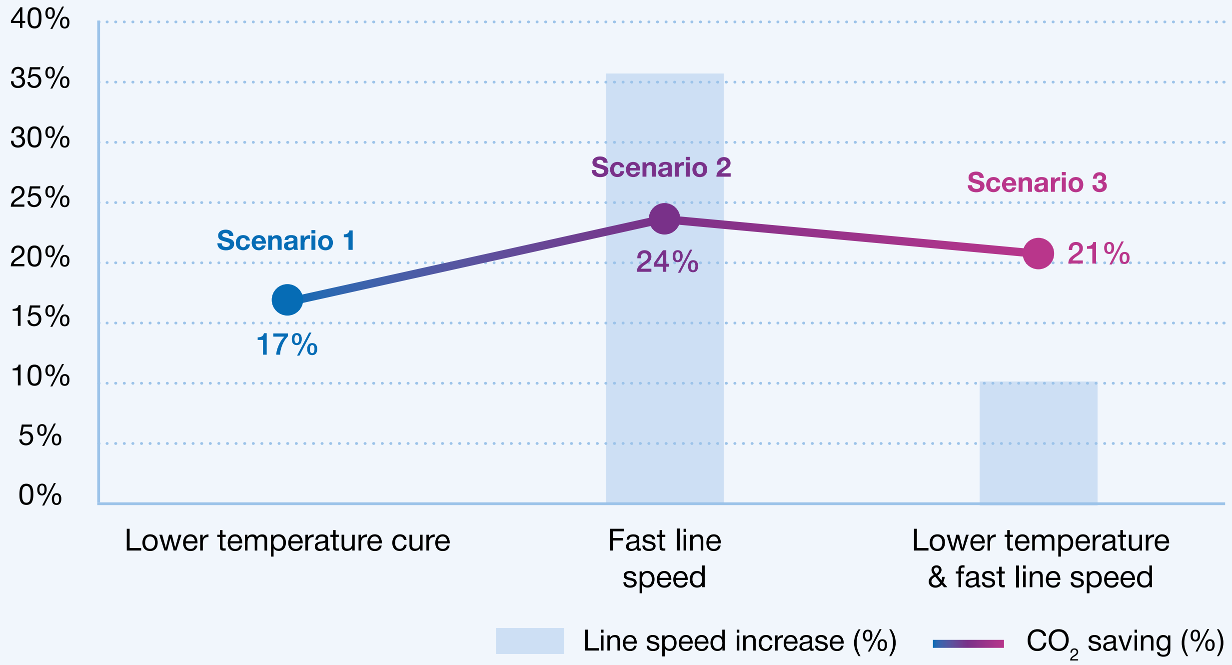
By enabling lower curing temperatures or faster line speeds, this innovation helps reduce Scope 3 emissions of powder coatings applicators across the value chain. It can lead to **up to 20%[13] energy savings and $CO_2$ reduction on application lines through lower curing temperatures,** or boost productivity by up to 25%[13] by increasing application line speed.

Both energy saving options can be achieved by low temperature cure systems. To illustrate their impact on $CO_2$ reduction, we analyzed three scenarios on a representative powder coating line:

**Scenario 1**
**Lower Temperature Cure:**
Oven temperature reduced by 25°C from the standard cure temperature setting
**→ PCF savings: 17%**

**Scenario 2**
**Fast Line Speed:**
Line speed increased by 36% while maintaining the standard oven temperature
**→ PCF savings: 24%**

**Scenario 3***
**Combined Approach:**
Oven temperature reduced by 15°C and line speed increased by 10%
**→ PCF savings: 21%**




**Combined approach is more realistic since running the line at its maximum speed (as in Scenario 2) is often difficult.*

04

# Next steps: advancing towards ***a net-zero powder coatings*** value chain

## From $CO_2$ reduction to neutrality

The journey to net-zero is a **continuous effort** and while considering a PCF which is up to 40%[4] lower than external reference is a promising start, achieving full climate impact mitigation will require **more efforts across the entire powder coating value chain.**

Even though this chapter does not emphasize the importance of collecting supplier-specific carbon footprint data for all raw materials, such data remains essential to truly lowering carbon emissions across the entire value chain. This chapter outlines the key levers and innovations that will drive the next wave of carbon emission reductions, as the industry moves beyond early wins towards true climate neutrality.

## 1 Optimizing Raw Materials for Net-Zero Coatings

### Towards more sustainable feedstocks

Reducing the embodied fossil carbon in raw materials remains one of the most impactful levers for lowering the overall carbon footprint. Building on the successful transition from fossil-based NPG to bio-attributed[6] NPG ZeroPCF[9], the next logical step is to replace, in an affordable way, all remaining virgin fossil raw materials with **100% alternative feedstocks**, whether through mass balance or through full physical segregation, where renewable raw materials are kept separate throughout the entire production process.

**Replacement of other raw materials** such as isophthalic acid or terephthalic acid can be considered as a next step for polyester resins, either with mass balance approach or replacement of i.e. fossil-based TPA with recycled PET (r-PET). Environmental benefit of r-PET is only meaningful when using post-consumer PET waste — not industrial PET scrap — as it truly contributes to reducing the reliance on virgin fossil raw materials. To enable broader use of r-PET resins across various applications require further product development to meet durability and quality requirements.

Overall, the continuous drive for transparency on supplier specific PCF data will remain a key task on the journey to net zero coatings.

### Enhancing $TiO_2$ efficiency

As one of the most widely used pigments in coatings industry, **$TiO_2$ contributes significantly to the overall carbon footprint** of light-colored formulations. Mitigating its impact requires a need for sustainable and affordable solutions via process innovations or by exploring $TiO_2$ substitutes in coating formulations.

### Transitioning to full polyester: a sustainable shift for powder coatings

A promising area for further carbon footprint reduction lies in reformulating other powder coating technologies where possible, i.e. hybrid powder coatings — for which polyester resins are crosslinked with epoxy resins — towards polyester technologies. Hybrid systems typically have a significantly higher PCF, primarily due to the carbon intensity of epoxy resins. Transitioning from hybrid to polyester formulations where application does not require chemical resistance could therefore yield substantial carbon emission savings.

## 2 Reducing the greenhouse gas impact of energy used, beyond electricity

Reducing carbon emissions from transformation and production processes along the powder coatings value chain will require a broader transition to renewable energy sources **beyond electricity**, which is already widely used in many manufacturing sites. **Heat generation** — especially for resin production, curing processes, or metal treatment — **still relies heavily on fossil fuels** and represents a major opportunity for reduction of carbon emissions. Key enablers for the next phase of the energy transition include:

**Biogas and biomethane:** These renewable gases, produced from organic waste streams or certain crops, can serve as lower-carbon emission **drop-in replacements for natural gas in existing thermal equipment**. They provide flexibility for facilities that cannot immediately shift to full electrification or hydrogen.

**Electrification of thermal processes:** Where technically viable, **switching from fossil fuel combustion to electric heating systems** (powered by renewable electricity) can drastically cut emissions, particularly in curing ovens or chemical reactors. While direct electrification would be the choice for curing ovens, chemical reactors often require steam, which can effectively be decarbonized with industrial scale heat pumps. Both measures require investment (in adapted equipment) but offer a direct path to decarbonization.

**Renewable hydrogen:** A promising solution for heat-intensive processes where electrification is not feasible. As green hydrogen becomes more accessible and infrastructures develop, it offers the potential to **replace natural gas in high-temperature applications** with near-zero carbon emissions.

## 3 The new benchmark for durability

In the Building & Construction industry, durability is more than a performance attribute, it's a key driver of sustainability. When all factors are taken into consideration — warranties on buildings, frequency of cleaning on the buildings, need for replacing exposed parts, value for money — **superdurable powder coatings now set the benchmark** for longer-lasting architectural applications in comparison with standard durable coatings (meeting Qualicoat Class 1, GSB Florida 1 standard requirements). By extending the lifespan of both the coating and protecting the underlying substrate, superdurable powder coatings reduce the need for maintenance, recoating, and replacement. This results in lower material and energy use, less waste, and fewer emissions from application and transportation. At the same time, preserving components like aluminium facades or profiles delays renovation, recycling, and raw material extraction.

Importantly, **when a coatings' PCF is spread over a longer lifespan, its annual impact is significantly reduced**. Combining long-term durability with a low initial PCF makes superdurable coatings an especially effective solution for reducing emissions in the built environment.

**Extra features for extra savings**

Designers can also leverage additional features of powder coatings to enhance sustainability. For instance, coatings with **low solar absorption** or heat **reflective properties** can help keep surfaces cooler in hot climates -— reducing energy consumption for cooling and improving thermal comfort in buildings.[8]

Powder coatings also offer **aesthetic versatility**, allowing architects to mimic the look of natural materials without their environmental drawbacks. For example, some finishes can give aluminium the appearance of natural and glazed Terracotta or Stone, such as Portland stone, limestone or brick — offering visual appeal with a guranteed durability, lighter weight, and reduced resource extraction.

CALL FOR ACTION

## Rethinking EPDs — Recognizing mass balance and durability to accelerate the transition to low-carbon footprint construction

To reach net-zero targets in the Building & Construction industry — responsible for 37%[2] of global greenhouse gas emissions — each lever for carbon emission reduction must be activated. Among these, two yet under-recognized factors merit consideration: the **mass balance allocation method** and **the durability levels of coatings.**

Despite its proven effectiveness and growing adoption in sectors such as biofuels and forestry, credit with mass balance is still not recognized in Environmental Product Declarations (EPDs). Of course, to fully harness the PCF reductions already achieved through bio-attributed raw materials, some prerequisites are essential: reaching a shared definition of mass balance and standardizing the methodologies used to calculate the share of bio-attributed content. At the same time, **integrating mass balance into EPDs represents a promising, scalable, and already proven approach to accelerate the transition towards carbon emission materials**. Recognizing this method would help to align sustainability assessments with actual progress made in the industry, and support broader adoption of innovative, more sustainable raw materials. To unlock the full potential of lower-PCF coatings — and incentivize further innovation — the inclusion of mass balance methodologies in EPD frameworks would be a significant step. It would ensure that sustainability claims align with real-world impacts and encourage engagement across the entire value chain.

An equally important issue is the lack of recognition for coatings durability — a critical yet often overlooked factor in EPDs. This is especially relevant today, as superdurable powder coatings are becoming the new benchmark for architectural applications, directly contributing to longer-lasting buildings by extending their design life. Yet **EPDs still do not distinguish durability benefit between standard and more durable powder coatings:** both are evaluated in the same way (kg $CO_2$ equivalent/kg of powder), regardless of their actual lifespan. As a result, a coating designed to last decades is treated, from a carbon accounting perspective, the same as one that requires earlier maintenance or replacement — overlooking the clear sustainability advantage of extended durability. Reviewing EPD methodologies to better consider for both mass balance and durability would offer an holistic view of material performance — better reflecting the benefits of high-performance, lower-carbon footprint coatings over the full design lifetime of an object and supporting the transition towards a more circular and resilient built environment.

CONCLUSIONS

# Paving the way *for lower-carbon emission coatings* in a high-impact sector

This industry case study illustrates the ability of key players of the powder coatings value chain to take decisive steps towards lowering carbon emissions, achieving measurable progress both at the product level and further in line application processes. By reducing the Product Carbon Footprint (PCF) of key raw materials — such as shifting from fossil-based to bio- attributed[10] inputs — and by adopting renewable electricity, lower-temperature curing technologies, and continuously improving manufacturing processes, **the industry has demonstrated that reducing carbon emissions and maintaining high product standards can go hand in hand.**

These milestones are real contributions to global climate goals, especially in a sector like Building & Construction, which accounts for 37%[1] of global greenhouse gas emissions. Powder coatings are well-positioned to support this transition through their durability and now with lower carbon footprint.

The **next wave of progress lies in the full substitution of fossil-based** raw materials with emission reduced alternatives (e.g. via mass balance, bio-segregated, or circular feedstocks) and the continued optimization of manufacturing processes, including more sustainable energy sources.

To fully unlock the impact of these innovations, regulatory and market frameworks must evolve. **Acknowledging the credit mass balance approach in Environmental Product Declarations (EPDs) and accurately considering the durability of coatings** would enable a more precise assessment of the environmental advantages provided by next-generation powder coatings. These updates are essential to accelerate the adoption of sustainable solutions across the Building & Construction sector, enabling informed decisions and incentivizing $CO_2$ emission concious choices throughout the value chain.

**The transformation is underway.** With continued collaboration, innovation, and recognition, powder coatings can be a cornerstone of a truly low carbon emission built environment.

(1) Global energy related carbon emissions according to the 2023 Global Status Report for Buildings and Construction.

(2) Paint and coatings industry overview, S&P, 2023.

(3) UNEP report (pg9): global_status_report_buildings_construction_2023.pdf.

(4) $CO_2$ refers to the emissions of all greenhouse gases, converted into $CO_2$ equivalents.

(5) Low-carbon aluminium | Hydro.

(6) Published EPDs | Institut Bauen und Umwelt e.V.

(7) TfS: Together for Sustainability, is an initiative established in 2014 to promote sustainable practices in the chemical industry. It sets the gold standard for the calculation of product carbon footprint (PCF) in the chemical industry.

(8) Superdurability means demonstrated lifespan-extension/material protection benefit compared to standard reference available on demand. Architectural superdurable powder coatings in the industry case study refer to AkzoNobel designed color collections (The color collections refers to Interpon D2525 Futura,Anodic, Stone-Effect, Natural Metals and Terracotta and D2015 Precis Ultra- Matt) and Interpon D2525 Low-E range meet Qualicoat Class2 and GSB Florida 3 industry standard requirements.

(9) PCF calculation at BASF is cradle-to-gate including biogenic carbon uptake, calculated according to ISO 14040, 14044 and 14067, and in line with Together for Sustainability (TfS) guidelines. A PCF of zero is achieved by the use of The Biomass Balance Approach and renewable electricity. For further information, please visit ZeroPCF Intermediates.

(10) BASF feeds renewable raw materials into its Verbund in the very first steps of chemical production and attributes a corresponding share of the renewable raw materials to specific sales products by means of a certified mass balance method. For further information, please visit The Biomass Balance Approach.

(11) Versus industry average data from the CEPE V4 database for polyester resins. Calculated according to ISO 14067 and TfS guideline V3 PCF methodology at cradle-to-gate, including biogenic removals (around 6%).

(12) Versus the former carbon footprint calculated for these products. Calculated according to ISO 14067 and Together for Sustainability (TfS) guideline V3 PCF methodology at cradle-to-gate, including biogenic removals (around 5%), and compared with industry average data from the CEPE V4 database for polyester resins (up to 35%).

(13) Versus standard curing technology - Eco+ Cure Energy: powder.interpon.com/true-sustainability/energy-saving/

(14) Interpon D2000 EPD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