Net-zero: decarbonization & diversification in EU climate benchmarks

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As the push for rapid decarbonization intensifies, investors are increasingly turning to the European Union Climate-Transition (CTB) and Paris-aligned benchmarks (PAB) to guide portfolio decarbonization. Due to varying carbon footprints across sectors, decarbonization rates differ significantly. This article examines how decarbonization trajectories and climate benchmark alignment affects portfolio diversification and risk.

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Executive summary

- The EU Climate-Transition (CTB) and Paris-Aligned Benchmarks (PAB) provide measurable pathways for investors to achieve net-zero targets within their equity portfolio.
- Implementation guidance: the benchmark guidance allows flexibility in rebalancing and reweighting but requires maintaining exposure to high-impact sectors.
- Simulation results: Maintaining high-impact sector exposure leads to **overallocation** of firms with the lowest footprints, making sector classification crucial.
- Long-term: CTB and PAB-aligned portfolios tend to **concentrate on sector, country and issuer-level**, with a clear tilt towards growth stocks.
- Emission pathways: Demand growth in certain high-impact sectors outpaces per-unit footprint reduction, increasing absolute emissions under various scenarios.

This article discusses considerations for investors committed to achieving net-zero greenhouse gas emissions by 2050 or sooner, in line with global efforts to limit warming to below 1.5°C.

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Introduction

Over the past decade, institutional investors have become more aware of the carbon emissions associated with their investment portfolios. Improved data quality and availability has made carbon emissions a valuable and important metric for sustainability reporting. Additionally, more institutional investors are now setting future carbon reduction targets, such as 2050 net-zero commitments. As the urgency for global decarbonization grows, so does the need for investors to find practical investment solutions to meet their portfolio reduction targets.

The introduction of the EU climate benchmarks, along with their framework and guidelines, provides investors with a clear and cost-efficient solution for decarbonizing their investment portfolio. These benchmarks aim for a large initial carbon footprint reduction compared to the parent benchmark, along with an average 7% year-on-year carbon footprint reduction target, while keeping exposure to high impact sectors (as defined by NACE classification, see appendix 4) in line with the parent benchmark.

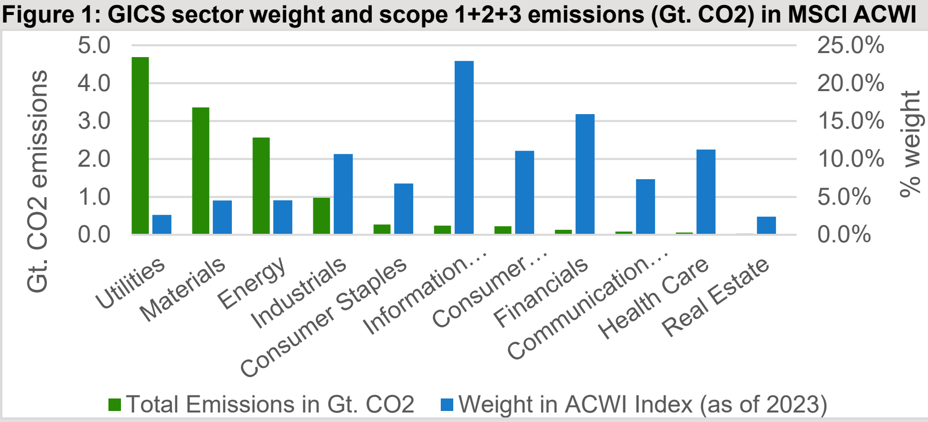
This article explores the characteristics, methodology, and implications of EU climate benchmarks on equity portfolios, with insights applicable to other asset classes as well. To evaluate the future impact of these benchmarks on investment portfolios, we simulate the benchmark composition 11 years ahead, using the MSCI All Country World Index (MSCI ACWI) as a proxy for the global equity market (see Box 1).

In our simulations, we use the NGFS (Network for Greening the Financial System) current policies scenario as the base case for emissions growth. We also apply sector-specific pathways from the Transition Pathway Initiative (TPI) for the emissions growth of the most carbon-intensive sectors under a current policies scenario. Additionally, we simulate the growth of companies (enterprise value) using GDP growth as a proxy. Our analysis focuses on the sectoral and geographical distribution of future benchmark compositions, hypothesizing that the uneven pace of decarbonization across firms, sectors, and countries may affect diversification.

Box 1: MSCI All Country World Index

The MSCI All Country World Index (MSCI ACWI) serves as a useful proxy for the global equity market. In 2023, companies in the MSCI ACWI emitted 12.6 gigatons of CO_2, accounting for about 35% of global CO_2 emissions.[1] The figure below highlights the discrepancy between sector weights (using GICS sector classification) and their share of total carbon emissions within the MSCI ACWI (based on scope 1+2+3). Approximately 90% of the total CO_2 emissions from companies in the MSCI ACWI come from just four sectors, predominantly utilities, materials, and energy.

Figure 1: GICS sector weight and scope 1+2+3 emissions (Gt. CO2) in MSCI ACWI



[1] Based on 2023 global CO_2 emissions of 35.8 Gt. CO_2: [Global carbon emissions in 2023 | Nature Reviews Earth & Environment]

Net-zero ambition

The urgency for decarbonization has never been greater. IPCC (Intergovernmental Panel on Climate Change) scientists predict that global warming could reach 2.5°C, with a 1.5°C limit nearly unattainable (in fact, those levels are already being breached in monthly measures [2]). We are currently witnessing a 13-month global temperature record streak, leading to severe climate-related disruptions worldwide. The IPCC has determined that the current rate of global warming is unprecedented, emphasizing the urgent need for drastic changes in the global economy to avoid climate catastrophe. While some may argue that 'green capitalism' is flawed, we argue that investors can play a crucial role in helping to decarbonize the global economy. Transitioning to a low-carbon economy is the pragmatic way forward.

Most institutional investors recognize the urgency of decarbonization and have committed to ambitious targets, such as net-zero pledges. However, there is a disconnect between decarbonizing investment portfolios and achieving real-world emission reductions. Ideally, firms decarbonize at a pace that negates the need for investors to adjust allocations to meet their own portfolio-level commitments. Reaching net-zero targets often involves reducing exposure to carbon-intensive sectors or shifting to the lowest-emitting firms within these sectors. This might increase the cost of capital for high emission firms but may not lead to the desired real-world emission reductions. See Box 2 for additional discussion on the disconnect between real-world impact and portfolio-level decarbonization.

"Ideally, firms decarbonize at a pace that negates the need for investors to adjust allocations in order to meet their own portfolio-level commitments. In reality, reaching net-zero targets often involves reducing exposure to carbon-intensive sectors or shifting to the lowest-emitting firms within these sectors."

Box 2: Paper portfolio decarbonization vs. real-world reductions

Investors set portfolio-level carbon reduction targets to promote real-world decarbonization and transition the economy towards greener alternatives. However, real-world decarbonization differs from what we might call 'paper portfolio decarbonization.'

To meet targets like the 7% annual reduction for EU Climate benchmarks, investors often reduce allocations to carbon-intensive firms and reallocate to cleaner ones. This reallocation doesn't necessarily lead to real-world decarbonization. While portfolio emissions may decrease on paper, disinvested firms might continue operating as usual, resulting in no actual impact. Recognizing this disconnect is crucial. We must use available tools wisely to promote real-world decarbonization rather than just paper portfolio decarbonization. See Box 3 for an example of using sector-specific targets to achieve more real-world impact.

While divestment is one tool, other strategies like engaging with large polluters, such as the oil and gas industry, have yet to deliver the desired outcomes.[3,4] Collective efforts like Climate Action 100+ have seen a significant decrease in total assets under management (AuM) as several large asset managers have withdrawn from the initiative.[5] A decarbonization pathway for investment portfolios is a powerful tool that complements engagement efforts by exerting pressure on corporations. Fixed decarbonization targets pose a risk of disinvestment if corporations fail to decarbonize, potentially raising the cost of capital. However, disinvestment can also have the opposite effect, as investors lose their influence on corporate decisions, potentially reducing incentives for companies to decarbonize or transition.[6] To support portfolio-level decarbonization, the Technical Expert Group (TEG) of the European Union (EU) launched the Climate Transition Benchmark and Paris-Aligned Benchmark, helping investors align their portfolios with a net-zero goal.

[2] UN, 2024: https://www.un.org/en/climatechange/science/climate-issues/degrees-matter

[3] World Benchmarking Alliance, 2023: https://www.worldbenchmarkingalliance.org/news/research-reveals-no-oil-and-gas-companies-have-plans-in-place-to-phase-out-fossil-fuels/

[4] Opinion piece on engagement: https://gofossilfree.org/uk/why-not-engage/

[5] Newsarticle, France24.com: https://www.france24.com/en/live-news/20240215-big-firms-with-7-tn-exit-climate-investment-pressure-group

[6] Divestment: Dynamic or Distractive?, Aegon Asset Management (November 2023). See: divestment-dynamic-or-distractive-november-2023-final.pdf (aegonam.com)

EU Climate Benchmarks

In 2019, the EU Technical Expert Group on Sustainable Finance (TEG) issued guidelines for climate benchmarks, following the EU's 2016 regulation on climate investment benchmarks. The report introduced two methodologies to help investors align their portfolios with a 2050 net-zero target: the Climate Transition Benchmark (CTB) and the Paris-Aligned Benchmark (PAB). The PAB is more ambitious, requiring a 50% reduction in portfolio-wide GHG emissions compared to the parent index. Both benchmarks aim for an average annual portfolio footprint reduction of about 7% until 2050.

Excluding the energy sector from the PAB benchmark would significantly reduce carbon intensity initially. However, this approach also means divesting from companies crucial for the low-carbon transition, which could undermine long-term environmental goals. A balanced approach that includes these key players while encouraging their shift towards greener practices might be more effective.

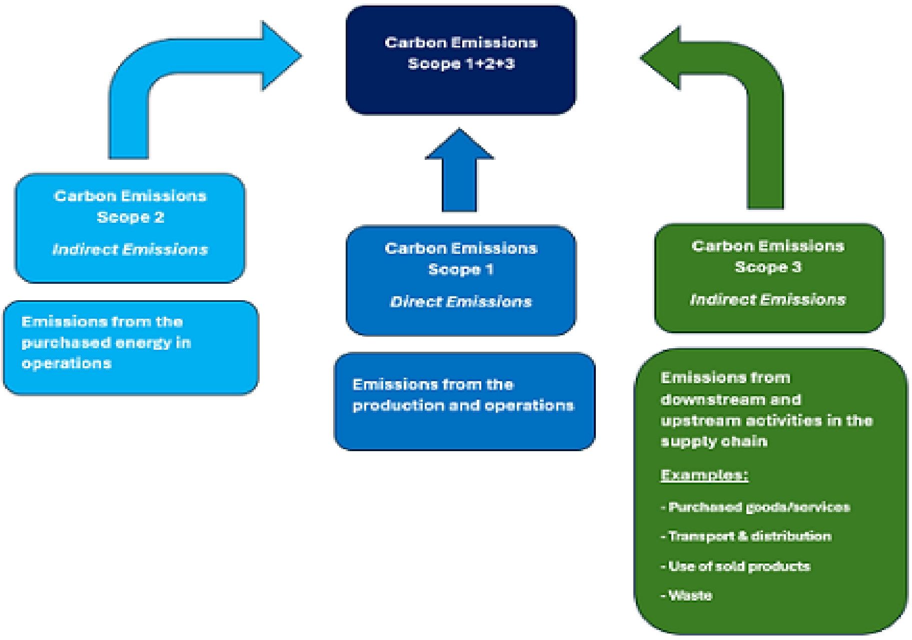
Carbon footprint

Before diving into our analysis, it's crucial to introduce some key metrics and concepts used in the EU Climate benchmarks. Companies are assessed based on their carbon intensity (or **carbon footprint**), which is the carbon emissions (scope 1, 2, and 3) per million EUR of enterprise value including cash (EVIC). The formula for carbon intensity is as follows:

$$Carbon\ Intensity_{t,i} = \frac{Carbon\ Emissions\ (scope\ 1+2+3)_{t,i}}{Enterprise\ Value\ Including\ Cash_{t,i}} \times EVIC\ Correction\ Factor \quad (\mathbf{1})$$

The formula includes a company's carbon emissions (scope 1, 2 and 3) at time t. Scope 1, 2 and 3 cover all emissions from operations, including production, energy use, and third-party up and downstream activity. Traditionally, only scope 1 and 2 were used due to double counting issues with scope 3, where one company's scope 3 emissions can be another's scope 1. Including scope 3 is crucial, especially for sectors like car manufacturing, as it captures supply chain emissions. TEG guidelines and EU legislation require using all scopes to calculate carbon intensity, despite the risk of double counting. To avoid this, a thorough investigation of the supply chain is needed. For simplicity, our analysis includes scope 3 emissions as given.

Figure 2: Breakdown of Carbon Emissions per scope



Source: Aegon Asset Management

EVIC

The denominator, enterprise value including cash (EVIC), provides a comprehensive valuation for comparing equities and corporate bonds. EVIC includes the market value of shares, debt, minority interests, and cash. It also introduces an additional perspective: if EVIC grows while emissions remain constant, carbon intensity decreases, indicating better carbon management. This suggests that a company is improving its carbon intensity management even if emissions haven't decreased. While EVIC may increase due to company autonomous growth (in which case unchanged emissions do reflect better carbon management), EVIC increase may just reflect inflationary effects. To account for these, a correction factor adjusts the carbon intensity calculation to reflect changes in average EVIC, ensuring that an increasing EVIC only lowers the firms' footprint when company EVIC is outpacing average EVIC increase. This adjustment factor is calculated as follows:

$$EVIC\ Correction\ Factor = \frac{\sum_t Weight_{t,i} \times EVIC_{t,i}}{\sum_t Weight_{t-1,i} \times EVIC_{t-1,i}} \quad (2)$$

Table 1 highlights the main characteristics and differences between the CTB and PAB benchmarks. The PAB has a more ambitious carbon reduction trajectory, with a 50% initial reduction compared to 30% for the CTB, mainly due to excluding energy companies. In 2023, the carbon footprint of the MSCI ACWI index was 353 metric tons CO_2 per million EUR EVIC for the CTB benchmark, compared to 283Mt for the PAB, illustrating the significant impact of carbon-intensive sectors.

Active sector weight constraint

A key feature of the EU climate benchmarks is the high-impact sector active weight constraint, requiring both CTB and PAB to maintain at least the same aggregated weight in high-impact sectors as the parent index (MSCI ACWI). In 2023, high-impact sectors comprised 60.6% of the index, while low-impact sectors were 39.4%. This constraint prevents significant deviations in high-impact sector exposure, avoiding over-allocation to low-impact sectors. The constraint applies to overall aggregated exposure, allowing individual sector shifts as long as the total weight matches the parent index.

This constraint implicates that climate benchmarks reduce the equity portfolio's carbon footprint by allocating more weight to the least carbon-intensive companies within high-impact sectors (best-in-class) and less to the most carbon-intensive ones. This confines the carbon footprint trade-off to high-impact sectors, significantly affecting the distribution of weights among companies in the EU climate benchmarks. Its influence on outcomes will be further examined in our analysis.

The requirement to maintain overall high-impact sector exposure is challenging because the high/low impact classification doesn't consider company-level carbon intensity. For example, a high carbon intensity company could be classified as low-impact and vice versa. Two companies in similar industries with the same low carbon intensity could be classified differently, leading to an overweight of the high-impact sector company compared to the low-impact one. Therefore, the company's classification in either high or low impact is crucial. Appendix 4 includes a list of the NACE sectors determining the high/low classification.

"The requirement to maintain overall high-impact sector exposure confines the carbon footprint trade-off to high-impact sectors, significantly affecting the distribution of weights among companies in the EU climate benchmarks."

Table 1: CTB & PAB benchmark characteristics

	Climate Transition Benchmarks (CTB)	Paris-Aligned Benchmarks (PAB)
Focus	CTBs incorporates specific objectives related to the reduction of carbon emissions and the transition to a low-carbon economy	PABs align with the Paris Agreement's objective of keeping the global average temperature increase to below 2°C above pre-industrial levels
Decarbonization rate	Minimum Initial decarbonization of **-30%** Minimum average reduction of -7% per annum in carbon intensity*	Minimum Initial decarbonization of **-50%** Minimum average reduction of -7% per annum in carbon intensity*
Sector exposure	Companies involved in thermal coal, oil & gas exploration are eligible in the benchmark	Companies involved in thermal coal, oil & gas exploration are excluded based on the % of revenue that is associated with these activities
Exclusions	**1.** Controversial weapons **2.** Production and cultivation of tobacco **3.** Violation of UNGC principles** **4.** Environmental harm*	**1.** Controversial weapons **2.** Production and cultivation of tobacco **3.** Violation of UNGC principles** **4.** Environmental harm* **5.** + 10% of revenue from coal **6.** + 50% of revenue from gaseous fuels **7.** + 50% of revenue from coal, liquid fuel & gas-based power generation
Diversification constraints	The combined weight of high-impact sectors (as defined by the NACE classification) in the climate benchmark is at least equal to the cumulative weight of those sectors in the parent index (non-climate benchmark)	The combined weight of high-impact sectors (as defined by the NACE classification) in the climate benchmark is at least equal to the cumulative weight of those sectors in the parent index (non-climate benchmark)

Source: Journal of the European Union (July 2020), MSCI (October 2022). * 7% reduction per annum is a guideline in the TEG Final Report and used by MSCI ** The legislation of the European Union points out that these exclusions are benchmark provider specific which implies that there is some lenience in how companies are classified as being in violation of the UNGC principles.

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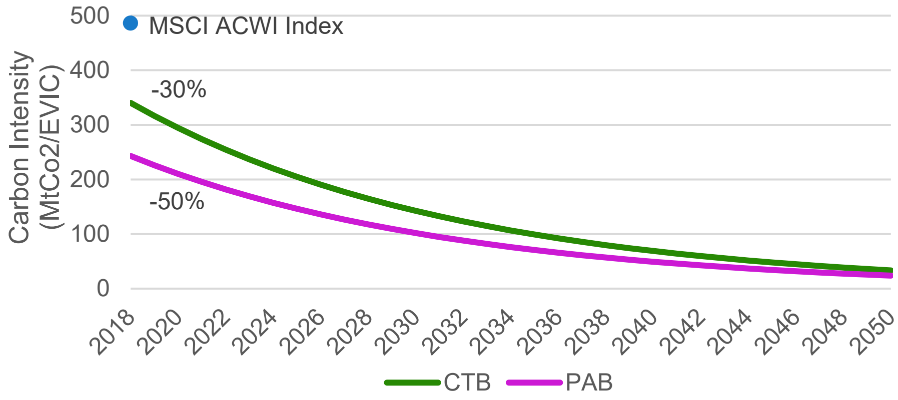
Figure 3 illustrates the carbon reduction trajectory of the ACWI Index according to CTB and PAB methodologies, as detailed in Table 1 under "Decarbonization rate." The initial carbon reduction is -30% for the CTB and -50% for the PAB, calculated from the initial carbon footprint of the MSCI ACWI index (parent index). From 2019 onwards, the portfolio carbon footprint is reduced by 7% annually until 2050. As shown, the absolute difference in carbon footprint between the CTB and PAB decreases over time, while the relative difference remains around 28%.

Initially, there's a significant discrepancy in the absolute carbon footprint between the two benchmarks. Over time, reducing the portfolio's carbon footprint becomes more challenging as more companies and sectors must adjust their weights to meet the targets.

Figure 3: Carbon reduction trajectory of CTB/PAB for the MSCI ACWI Index



In the following sections, we will examine how these climate benchmarks affect diversification, concentration risk and other metrics like the P/B ratio in an equity portfolio. As more investors adopt the EU benchmarks, we aim to further explore their long-term implications, especially focusing on sectoral decarbonization. We hypothesize that due to the diverse decarbonization trajectories of sectors, following a CTB or PAB-aligned investment approach could result in concentrated portfolios with specific tilts over the long term.

Readers should note that, although our analysis aligns with EU legislation and loosely follows the MSCI interpretation and methodology, it is subject to assumptions detailed in Appendices 1-2, particularly those regarding future pathways.

Decarbonization and diversification

Diversification is crucial for managing risk and achieving higher risk-adjusted returns. However, portfolio decarbonization challenges diversification, as sectors and firms transition to a low-carbon economy at different rates. Beyond oil and gas, other carbon-intensive sectors like cement, steel, aviation, and agriculture also pose significant challenges to reducing a portfolio's carbon footprint.

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Modern portfolio theory underscores the need for diversification. The formula for portfolio volatility with two assets (equities) can be extended to more stocks while maintaining the same principle:

$$\textbf{\textit{Portfolio Volatility}} = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\sigma_1\sigma_2\rho_{12}} \quad (3)$$

w : weight of individual stock in the portfolio

σ : standard deviation of the returns of an individual stock in the portfolio

ρ : correlation between the returns of the two stocks in the portfolio

Reduced diversification and increased sector concentration risk affect the portfolio as follows:

- A more sector-concentrated equity portfolio will have higher correlations among companies within the same sector, increasing the third term in the formula.
- This effect is magnified if heavily weighted stocks in the benchmark are highly correlated.
- Carbon-intensive sectors (e.g., materials, utilities, industrials) are typically value stocks with low P/B ratios and less volatile returns. If the climate benchmark shifts towards growth stocks, it may increase portfolio volatility through the higher associated volatility with those stocks.

The correlation matrix in Appendix 3, based on daily total returns per sector in 2023, shows that carbon-intensive sectors like energy, utilities, and materials have low correlations with information technology, benefiting diversification. The energy sector in particular— has the lowest correlations with other sectors. However, the PAB benchmark excludes large parts of the energy sector (based on the exclusions in table 1), reducing diversification based on correlation. Conversely, energy sector returns are characterized by relatively high volatility, which contributes to overall portfolio volatility. On average, decreasing exposure to carbon-intensive sectors in favor of less carbon-intensive ones increases portfolio volatility, potentially leading to lower risk-adjusted returns for investors.

In a low-carbon economy, diversification may take on a new form. Traditional sectors may lose prominence, while sustainable sectors rise. This shift offers new diversification opportunities aligned with decarbonization goals. Adaptation, not just preservation of old diversification standards, is key. Rapid exclusion or underweighting of certain sectors may not accelerate the transition to low-carbon alternatives (see Box 2). Some sectors may struggle to decarbonize at the required rate, while other sectors may have an easier time and can buy their way into low-carbon alternatives (see Box 3).

Box 3: Sector-specific decarbonization

Consider the steel sector: Despite growing environmental consciousness, the increasing world population and GDP growth suggest a likely rise in global demand for steel (also see Appendix 2). Hydrogen-based steel production may start to gain traction eventually, but globally, steel production is unlikely to meet decarbonization requirements soon. Hydrogen alternatives as well as employing carbon capture, usage and storage (CCUS) at conventional plants is being developed, but mainstream adoption is years, if not decades, away. Consequently, following (paper) decarbonization regiments (e.g. PAB/CTB) could lead to divesting from the steel sector over time, even to firms with well-intentioned management.

Contrastingly, tech giants have a smoother decarbonization path, as their carbon footprint is primarily tied to their energy consumption (scope 2). While some claim near-complete carbon neutrality*, it's not representative of the entire sector. With more green-energy options, these firms can 'purchase' their way into emission reduction (note that we acknowledge the controversies surrounding carbon offsets and renewable energy certificates. Ideally firms invest in clean energy technologies applied directly onsite such as heat pump**s** and solar panels). The relative ease at which these firms can decarbonize compared to other sectors, could prompt investors to set higher standards for these firms while being lenient towards sectors having fewer alternatives. Interestingly, such an approach could be considered countercyclical. The prospect of divestment from traditionally cleaner sectors might surprise management. However, if this trend gains traction, it could bolster the economy's decarbonization efforts, provided the pressure on major polluters remains firm.

***Carbon neutrality is not equal to net-zero. The latter term considers all greenhouse gasses and focusses on reducing first and offsetting remainders.**

Construction of CTB/PAB benchmarks

Decarbonizing a portfolio typically involves reducing exposure to carbon-intensive companies and reallocating to less carbon-intensive ones, which can impact diversification. To illustrate the effect of the CTB/PAB methodology on equity portfolio diversification, we outline the key rules and concepts of this methodology, largely based on MSCI's approach to the EU climate benchmarks. While different methodologies may yield varying results, adhering to the EU's minimum requirements ensures consistency.

Table 2 outlines the methodology for constructing climate benchmarks and setting carbon reduction targets. This approach emphasizes the importance of the active weight restriction, the carbon intensity of companies and their ranking based on this intensity. As a result, carbon-intensive sectors are underweighted, while less carbon-intensive sectors are overweighted. Companies in high-impact sectors with relatively low carbon intensity become significantly overweighted and this effect intensifies over time due to increasing carbon footprint reduction needs.

"Companies in high-impact sectors with relatively low carbon intensity become significantly overweighted, and this effect intensifies over time due to increasing carbon footprint reduction needs."

Table 2: CTB & PAB construction methodology

Step	Actions
1	First, we start by calculating the carbon intensity for every company in the MSCI ACWI index (see formula 1 in previous section). If either the carbon emissions (scope 1+2+3) or the EVIC figures are missing for a company, we take the weighted average carbon intensity of the industry group the company with missing values is in. The industry group (GICS) is one level lower than the sectors (i.e. industrials, energy, information technology etc.)
2	The MSCI ACWI Index (the parent Index) represents the "applicable" universe. From here on the exclusions (see Table 1) are applied, for the CTB see exclusions 1-4 and for PAB exclusions 1-7. The universe of companies that remains is called the "eligible" universe. The eligible universe is formed by all companies that were not excluded. The remaining companies in the eligible universe are weighed to 100% on a pro rata basis.
3	The active sector weight, Ih was Introduced In Table 1 remains an Important restriction throughout the benchmark construction. The restriction states that the CTB/PAB benchmark should have the same weight in high and low impact sectors as the parent index (applicable universe). We divide the eligible universe into high and low impact sectors and weigh back the companies in the eligible universe (pro rata basis) so that it matches the exact weight in high and low impact sectors of the parent index (applicable universe).
4	The whole eligible universe (with the new weights of step 3) is sorted from the lowest carbon intensity to the highest carbon intensity on the company level.
5	The eligible universe is split by the number of constituents in a top half (highest carbon intensity) and bottom half (lowest carbon intensity).
6	In order to achieve a reduction in the carbon intensity of the portfolio, weight is redistributed from high carbon intensity companies in the top half to companies in the bottom half. The weight of the constituent in the universe with the highest carbon intensity is weighed down with incremental steps of 25% until an individual firm is down weighted by at most 75%. The weight that is reduced gets distributed on a pro rata basis over the companies in the bottom half. This is repeated for the constituent with 2nd highest carbon intensity and so forth until the carbon intensity of the portfolio meets the imposed reduction target for the given year.
7	To meet the CTB and PAB restriction on active sector weight, the weight of companies in the top half that classify as being in high impact sectors gets distributed over the high impact ones in the bottom half. The same applies for companies in the low impact sectors.

Source: MSCI, Aegon Asset Management (as of 2024).

Table 3 shows the weighted carbon intensity per GICS sector and their distribution across high and low impact designations. GICS level 3 sectors can include both high and low impact classifications, as this distinction is made on the sub-industry GICS level 4 (also see the NACE classification in Appendix 4).

The aforementioned effect of reducing exposure to high-impact carbon-intensive sectors and re-allocating this weight to lower intensity sectors with the same classification, is most pronounced for the energy sector, with a shift towards healthcare and IT. Under the PAB, given the nearly full initial exclusion of the energy sector, other sectors are more prone to this effect. Other carbon-intensive sectors, such as industrials, materials and utilities, see significant reductions. The benchmark methodology, being sector-agnostic, substantially lowers the weight of these sectors.

Table 3: Weighted Carbon Intensity per GICS sector as of 2023

Sector	Carbon Intensity*	High Impact	Low Impact
Communication Services	23.1	0.0%	100.0%
Consumer Discretionary	309.4	81.2%	18.8%
Consumer Staples	256.1	100.0%	0.0%
Energy	1592.6	100.0%	0.0%
Financials	25.3	0.0%	100.0%
Health Care	32.6	70.4%	29.6%
Industrials	1233.6	81.3%	18.7%
Information Technology	47.1	61.0%	39.0%
Materials	1122.9	100.0%	0.0%
Real Estate	81.4	100.0%	0.0%
Utilities	958.1	100.0%	0.0%

Source: Aegon Asset Management, MSCI (2024). *MtCo2 per € million EVIC.

Long-term CTB/PAB simulation results

In our analysis, we applied the CTB/PAB methodology to the MSCI ACWI index for the 2018-2035 period, resulting in simulated CTB and PAB benchmarks. From 2024 onwards, we maintained the weights for each company in the MSCI ACWI universe at their Q4 2023 levels. Over the 2024-2035 horizon, the weights only differ due to the application of the CTB/PAB methodology. Emissions and growth (EVIC) of companies are simulated using data from the NGFS current policies scenario[7], with company growth proxied by GDP growth. For the most carbon-intensive sectors, we applied sector-specific pathways as outlined by the Transition Pathway Initiative. This means that we do not model future emissions on a per-company basis, rather we use future expected global emission increases and employ sector specific pathways for the most polluting sectors. See Appendices 1-2 for more details on the methodology used and assumptions made.

This simulation provides intriguing insights into potential trends and the consequences of aligning a broader equity mandate with these benchmarks. Before delving into the results, it is important to mention the data limitations that required us to incorporate various assumptions.[8] The outcomes of these simulations are quite sensitive to these assumptions. See Appendix 1-2 for more details as well as sensitivity analysis

[7] This study uses data from the NGFS Climate Scenario GCAM 6.0. See NGFS website and assumptions table for additional details: https://www.ngfs.net/ngfs-scenarios-portal/explore/

[8] In Table 2 we have set out the used index construction methodology which resembles the MSCI CTB/PAB methodology and adheres to EU legislation on climate benchmarks. Furthermore, we have added to this methodology sector-specific growth rates for a company's carbon emissions and EVIC which is set out in Appendix 1-2.

Despite the numerous assumptions, our simulations incorporate EU legislation (see Table 1) and the core principles of the MSCI CTB/PAB methodology (see Table 2). In the following section, we will elaborate on the simulation results for the CTB and PAB benchmarks and discuss the implications for investors adhering to these benchmarks.

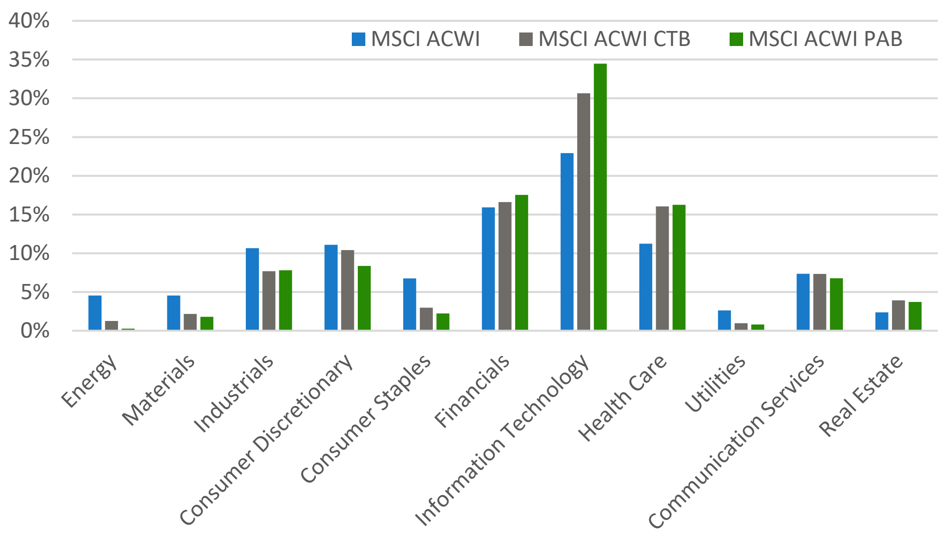
It is important to mention that various benchmark providers have incorporated additional measures within their own benchmark construction to mitigate some of the effects we have found below. In our simulations, we merely focus on the effects from applying a CTB/PAB overlay to an existing index and do not take additional measures into account.

Increased sector concentration

Our simulation aimed to examine the impact of the CTB/PAB methodology on sector diversification, given the constraints and reweighting schemes associated with these benchmarks. Figure 4 illustrates the sector distribution for the 2023 MSCI ACWI index compared to the forward simulated ACWI index with CTB and PAB overlays (according to the aforementioned methodology). The figure shows a significant skew towards less carbon-intensive sectors for the CTB index and an ever more pronounced effect for the PAB overlay.

"The IT sector's weight increases by approximately 8% for the CTB benchmark and 11% for the PAB benchmark. The healthcare sector sees increases of about 5% for both benchmarks."

Figure 4: Sector distribution in 2035 of CTB & PAB



Source: Aegon Asset Management, MSCI (as of 2024). Simulations consider the period 2018-2035, from 2024 onwards weights are simulated.

The weight of the energy sector, already low initially, becomes almost zero for the PAB benchmark due to the exclusions listed in Table 1. Similarly, the exposure to other carbon-intensive sectors like materials and utilities becomes almost negligible for both the CTB and PAB benchmarks. As the carbon footprint of the index must be reduced by 7% annually, most of the sector weight is redistributed among less carbon-intensive companies classified as high impact. This reweighting mechanism is driven by the high-impact sector aggregated active weight constraint (see discussion page 5).

Key observations:

- **Energy sector:** The weight of the energy sector, already low initially, drops to almost zero for the PAB benchmark due to exclusions.
- **Other carbon-intensive sectors:** Materials and utilities also see their weights reduced to negligible levels in both CTB and PAB benchmarks

- **IT and healthcare:** The IT sector's weight increases by approximately 8% for the CTB benchmark and 11% for the PAB benchmark. The healthcare sector sees increases of about 5% for both benchmarks.
- **Redistribution:** Most high-impact sector weight is redistributed to less carbon-intensive companies classified as high impact, driven by the high-impact sector aggregated active weight constraint. This results in redistributions towards healthcare and IT.
- **Growth tilt:** The overall weighted portfolio P/B ratio increases from 1.9 to 6.5 in 2035, introducing a major growth tilt. This calculation assumes constant P/B ratios over time.

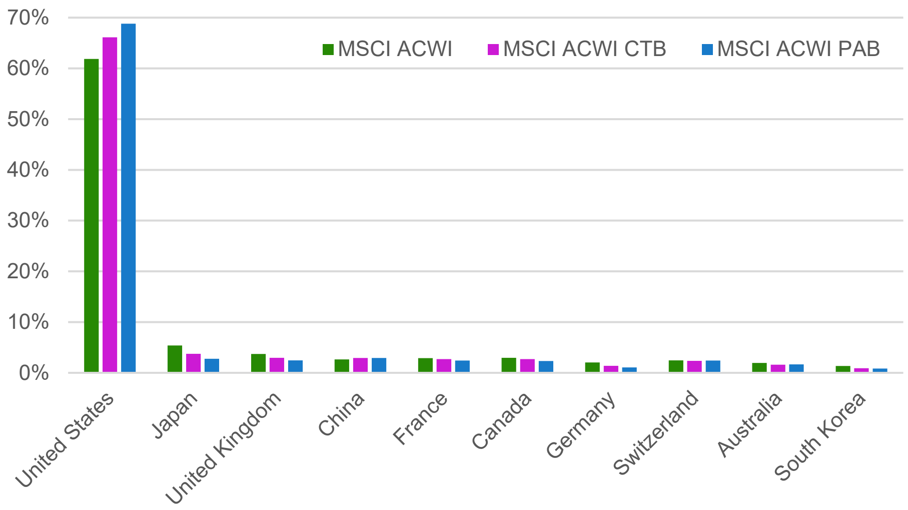
These sector shifts, while dependent on assumptions (see Appendix 1), indicate a real-world impact on portfolio diversification when implementing EU Climate Benchmarks.

"The IT sector's weight increases by approximately 8% for the CTB benchmark and 11% for the PAB benchmark. The healthcare sector sees increases of about 5% for both benchmarks."

US companies will dominate even more

One of the most notable findings from the simulations is the increasing weight of the United States in the CTB and PAB overlay indices. The US already holds a significant weight in the MSCI ACWI, just above 60% at the end of 2023. This increases to about 66% with the CTB benchmark and nearly 70% with the PAB benchmark. This rise is primarily due to the weight of US tech companies, which are considered high impact but have relatively low carbon intensity. As weight is redistributed on a pro-rata basis among companies in the bottom half regarding carbon intensity, US mega caps become significantly overweight. We will explore this phenomenon in more detail in the section on individual holdings.

Figure 5: Geographical distribution of top 10-countries in 2035 of CTB/PAB



Source: Aegon Asset Management, MSCI (as of 2024). Simulations consider the period 2018-2035, from 2024 onwards weights are simulated.

Key observations:

- **US tech:** The increase in exposure towards the United States is primarily due to the weight of US tech companies, which are considered high impact but have relatively low carbon intensity.
- **Future dominance:** As reliance on technology and AI-driven applications grows, these US mega cap companies are expected to become even more dominant in the coming decades. As the MSCI ACWI parent index was assumed to remain constant, this effect may be even more pronounced.

- **Decreased exposure to other developed markets:** The weights of Japan, the United Kingdom, and Germany decrease significantly due to their higher exposure to high-impact sectors with high carbon intensities.
- **Increased exposure to China:** The accumulated weight of China increases, attributed to its relatively high number of high-impact companies with lower carbon intensities.

These shifts highlight the growing dominance of US companies, particularly in the tech sector, and the changing landscape of global equity markets under the CTB and PAB frameworks.

Individual holdings: High impact but low carbon intensity companies thrive

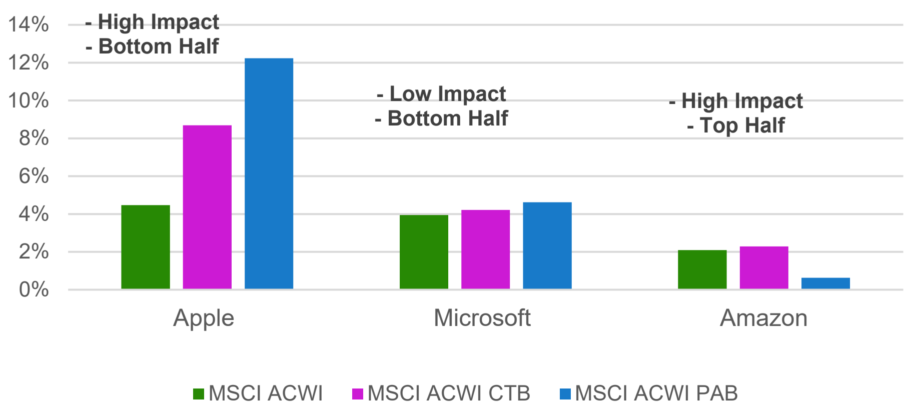
In 2035, the three largest positions in the CTB and PAB indices include Apple and Microsoft, which were also among the largest holdings in the parent index in 2018. Amazon, which was the third largest in 2018, is now the fourth largest in the CTB benchmark and has dropped out of the top-10 in the PAB benchmark.

The CTB/PAB methodology redistributes weight from high carbon-intensive companies to low carbon-intensive ones. High impact companies in the top half of carbon intensity get their weight distributed to those in the bottom half. This pro rata allocation gives Apple a larger share of the distributed weight. Although these companies may have comparable business activities, the sector classification has a profound impact on reweighting.

In the case of Amazon, another interesting feature of these CTB/PAB methodology comes into play. Amazon is classified as being in a high impact sector (consumer distribution & retail) but has a carbon intensity that puts them in the top half of the index regarding carbon intensity.

The significant difference in Amazon's weight between the CTB and PAB indices is due to its position in the top half of companies by carbon intensity. Amazon is among the companies with the lowest carbon intensity in this group. To reduce the carbon footprint in the CTB/PAB benchmarks, companies are incrementally weighed down by 25% of their weight, starting from the highest to the lowest carbon intensity in the top half. In the CTB index, Amazon did not need to be weighed down as reducing the weight of other companies with higher carbon intensities was sufficient. However, in the PAB index, Amazon's weight had to be reduced to meet the reduction target. This underscores the critical role of sector classification and relative carbon intensity in the CTB/PAB methodology, determining whether a company is over- or underweighted.

Figure 6: Issuer-specific holdings in 2035 for CTB & PAB



Source: Aegon Asset Management, MSCI (as of 2024). Simulations consider the period 2018-2035, from 2024 onwards weights are simulated.

Key observations:

- **Weight of Apple surges:** Exposure to Apple increases from 4.5% in the parent index to 8.7% (CTB) and 12% (PAB) in 2035, due to its classification as a high impact sector (hardware manufacturer).
- **Microsoft unaffected:** Its weight remains relatively constant due to the low-impact sector classification (software).
- **Weight redistribution:** The CTB/PAB methodology redistributes weight from high carbon-intensive companies to low carbon-intensive ones. High impact companies in the top half of carbon intensity get their weight distributed to those in the bottom half, benefiting companies like Apple.
- **Amazon:** Classified in a high impact sector (consumer distribution & retail) but with a carbon intensity in the top half of the index. In the CTB index, Amazon's weight remains relatively high, but in the PAB index, its weight is reduced to meet the reduction target.

These observations highlight the critical role of sector classification and relative carbon intensity in the CTB/PAB methodology, determining whether a company is over- or underweighted.

Conclusion

Our simulations reveal a significant overrepresentation of stocks from high-impact sectors with lower carbon footprints. This is primarily driven by the EU's imposed constraint on active weight in combined high-impact sectors, leading to undesirable outcomes.

As the weight of growth, IT, and US stocks increases, diversification decreases, and the overall correlation between the securities in a CTB/PAB index rises, leading to higher volatility. While this has recently earned investors additional returns due to the success of US IT companies, from both a diversification and fundamental investing perspective, it is undesirable for allocations to increase to the levels suggested by our simulations.

- **Concentration Risk:** For example, Apple's weight roughly doubled (CTB) and tripled (PAB), increasing the risk of concentration and causing overrepresentation of certain countries (like the US) and sectors (such as IT), leading to a growth tilt. This skew towards growth could change as companies mature.
- **Diversification decreases:** Increased weight in growth, IT, and US stocks reduces diversification and raises overall correlation, leading to higher volatility.

From a decarbonization perspective, CTB/PAB-aligned portfolios rely too heavily on the classification of sectors as high or low impact, without considering the individual sector's capacity for decarbonization. The CTB/PAB guidance imposes a restriction to maintain the overall weight to high and low impact sectors. During the reweighting step, firms in high-impact sectors with lower carbon footprints are overallocated to ensure overall exposure to high-impact sectors remains intact.

Although this classification system was introduced to broadly ensure that the sector composition stays intact, it also introduced some unwanted effects. Firstly, the interaction between high-impact sectors with low and high carbon intensities is significant, with major reallocations happening between these sectors. At the same time the classification of high and low is not as straightforward as it seems. In our analysis, the carbon intensity of Apple was lower than Microsoft, which was classified as low impact.

Such a binary approach to classifying companies might simplify things but does not do justice to the complexity that carbon reduction encompasses. Secondly, low-impact sectors do not gain from the redistribution of weight as these companies have relatively low carbon intensities. Intuitively, one would expect low-impact sectors to benefit from carbon reduction in a portfolio as they do not contribute as much to the carbon intensity of the portfolio. We believe there should be more leniency in deviating from the restriction on active sector weight.

- **Sector classification issues:** CTB/PAB portfolios rely too heavily on binary high/low impact classifications, not considering individual sector and firm decarbonization capacity.

- **High/Low impact ratio:** Deviating from the high/low impact ratio of the parent index could prevent excessive overweighting of individual companies.

In broader terms, The CTB/PAB methodology focuses on historical metrics like emissions and EVIC data but fails to incorporate forward-looking metrics such as a company's reduction targets or carbon intensity improvement. It also doesn't account for how well a company performs against its peers. Some sectors may lack viable options to reduce emissions without disrupting their business models. A sector-specific best-in-class approach that includes forward-looking metrics might be more effective. Using carbon intensity as the primary metric can be biased, as it focuses on relative emissions. Large companies might emit a lot of CO_2 but have low carbon intensity. Absolute emissions might be a better metric for achieving net-zero.

- **Metric limitations:** The methodology's reliance on historical metrics and carbon intensity can be biased, suggesting a need for forward-looking metrics and absolute emissions.

In this study, we explored the potential consequences of aligning with a CTB or PAB index from a risk and return standpoint and discussed their real-world impact on decarbonization. We projected the composition of a CTB/PAB-aligned index up to 2035 We will explore methods to improve CTB/PAB alignment by incorporating sector-specific pathways and applying more pressure on companies that have the potential to decarbonize faster. While the CTB/PAB indices are simple, cost-efficient, and easy to implement methods for (paper) portfolio decarbonization, our simulation indicates drawback such as concentration risk and possibly a lesser than desired real-world impact.

- **Possible improvements:** Future research will focus on maintaining CTB/PAB alignment with sector-specific pathways and increased pressure on companies able to decarbonize faster.

Appendix 1: simulation methodology and assumptions

To assess the impact of a decarbonization strategy on portfolio sectoral diversification, one should observe the deviation of sector weights over time and determine whether this deviation is within acceptable boundaries. As discussed before, while sectoral over/underweighting is unavoidable in the move towards a low-carbon economy (and not necessarily a bad thing), a lack of diversification may increase exposure to non-systematic risks and alter the risk/return profile of the portfolio.

To determine the impact of investing according to the EU Climate benchmarks on portfolio diversification, we performed a forward simulation of both the PAB and the CTB methodology. Simulating by definition requires us to make various assumptions and simplifications. Table 4 provides an overview of assumptions used in the simulation.

Table 4: Overview of assumptions used in the construction of the CTB/PAB benchmarks

No.	Subject	Assumption	Additional remarks
		Future sector-based emission and output assumptions	
1.1	Predicted GHG emissions high impact sectors	Future decarbonization of nine high-impact sectors* are assumed to follow sector specific pathways according to the Transition Pathway Initiative. * Airlines, Aluminium, Cars, Cement, Diversified mining, Electricity utilities, Oil & Gas, Shipping, Steel	- (Inter)national pledges scenario - These pathways are provided in a sector-specific output-based intensity metric. This is transformed to a carbon footprint using assumptions described in 1.2. - For 2 high impact sectors (food production & paper production), no data exist for the international pledges scenario. Therefore these are not modelled with a sector-specific pathway.
1.2	Sector-specific output assumptions	For the nine sectors mentioned in 1.1, the output-based intensity is converted to a carbon footprint using sector-specific output assumptions.	A complete overview of these assumptions per sector are shown in table 5.
1.3	Predicted GHG emissions other sectors	For all other sectors, not covered by TPI data, we assume the base year carbon footprint develops according to the reference footprint* *the reference footprint CF_{ref} is defined as: $$CF_{ref} = \frac{CE_t}{GDP_t}$$ With CE_t as the carbon emissions in year t, and GDP_t as the Gross Domestic Product (GDP) in year t as predicted by the NGFS nationally determined contributions scenario (NDC)	The NGFS scenarios are dependent on various assessment models. The carbon emissions and GDP time series are obtained from the GCAM 6.0 assessment model. Global carbon emissions are considered to be a predictor for total greenhouse gas emission for the sectors modelled in the portfolio (all sectors but the nine aforementioned). Due to selection effects (i.e. most sectors affected carry a smaller carbon footprint than average), this assumption may overestimate future emissions. GDP growth is used as a proxy of the average enterprise value including cash (EVIC) growth, which is the denominator in the carbon footprint metric. The NGFS scenario GDP growth assumptions are based on a baseline GDP forecast set by the International Monetary Fund (IMF), with adjustment percentages provided by the GCAM 6.0 assessment model.
		Simulation assumptions	
2.1	Index	The parent index used is the MSCI All Countries World Index (ACWI) with set weights on 31-12-2023.	The weights and composition of the parent index is kept constant throughout the simulation horizon (i.e. every simulation year parent index equals MSCI ACWI 12/2023)
		CTB/PAB assumptions	

2.1	Initial exclusions	Aligning with the guidance for CTB and PAB methodologies, the investable universe is reduced through excluding based on various rules:
2.2	Target	The EU guidance states the aim of reducing the portfolio carbon footprint with an average of 7% annually. To achieve this, we employ a rebalancing scheme similar to benchmark provider MSCI. Table 2 outlines the steps taken in each year of the simulation to rebalance the index in alignment with the CTB/PAB guidance.
2.3	Exposure to high impact sectors	The EU guidance specifically mentions that in accordance with CTB/PAB, the portfolio should maintain a 0% active weight to high-impact sectors as classified in appendix 4. This obligation results in maintaining the same weight distribution between the sum of high-impact and low-impact sector exposures. To comply with this, the rebalancing scheme detailed in table 2 involves reweighting steps to maintain the same high/low distribution over time.

Appendix 2: Implementing sector-specific pathways into a broader index simulation

In order to simulate the decarbonization of firms within high impact sectors in the best way possible, we use pathways provided by the Transition Pathway Initiative (TPI) for nine sectors[9]. TPI has mapped decarbonization pathways for various carbon-intensive sectors based on 3 scenarios: current international pledges, below 2c and Paris-aligned (1.5c). Aside from laying out these pathways, TPI provides an overview of large-cap firms within each sector and how they compare to the pathway. For each sector TPI determined an appropriate carbon-intensity benchmark, which unlike portfolio footprints, is not based on an EVIC denominator, but rather a output-based denominator. The aviation sector for example, is measured using gCO_2/RTK (Revenue Tonne Kilometres, revenue load multiplied by distance flown). Using output-based carbon intensities, inter-sectoral comparisons are much more appropriate and allows for best-in-class selection efforts. In our simulation however, we assume all firms within these sectors decarbonize at the same rate that the respective sector pathway indicates. So, no firm-specific decarbonization is modelled.

To use these sector-specific decarbonization pathways in our simulation, we have to translate output-based carbon intensities into the more general carbon footprint, used within the CTB and PAB reweighting procedure (see table 2). To perform this translation, we undertake the following steps:

1. For each TPI-covered sector, we determine the output-based intensity reduction for the current year according to the (inter)national pledges scenario as put forth by TPI.
2. We determine key inputs for the translation:
    - Output growth: Sectoral demand increase for the current year: $Y_{i,T}\%$
    - EVIC growth: Growth of average EVIC. Approximated by GDP increases: $X_{i,T}\%$
3. Implied sectoral carbon footprint reduction based on TPI pathway is obtained through:

$$IR_{i,t} = \frac{(1 + X_{i,t}\%)}{(1 + Z_{i,t}\%)}(1 + Y_{i,t}\%) - 1$$

    With $IR_{i,T}$ as the implied carbon footprint reduction for TPI-covered sector i at time t, $X_{i,T}\%$ as the output-based carbon intensity reduction provided by TPI for s sector i at time t, $Z_{i,T}\%$ as the EVIC growth for sector i at time t and $Y_{i,T}\%$ as the output growth for sector i at time t.

    - Example given for aviation:
        - With aviation TPI pathway implied reduction of -3%, RTK growth of 1% and average sector EVIC growth of 2%, according to the above formula, the expected portfolio footprint reduction for aviation is -3.95%

Note that the procedure above yields the relative increase or decrease of carbon footprints for specific sectors and can therefore be applied directly to the simulation of CTB/PAB-aligned indices. As we apply a simplified inflation adjustment[10] within the simulation, the effect of dividing by EVIC change (the $Z_{i,T}\%$ term from the formula above), is cancelled out. For the purpose of clarity, we obtain the footprint reductions according to the formula above and subsequently apply the inflation adjustment, instead of combining the two steps.

[9] TPI provides data on more high-impact sectors such as Paper production and Food production. For these sectors however, pathway data of the (inter)national pledges scenario is not included, leading us to model these sectors similarly to other non-TPI covered sectors.

[10] Multiplying footprints by the factor EVIC change of that given year, essentially adding the (1+$Z_{i,T}\%$) term back into the nominator, hence cancelling out the term entirely.

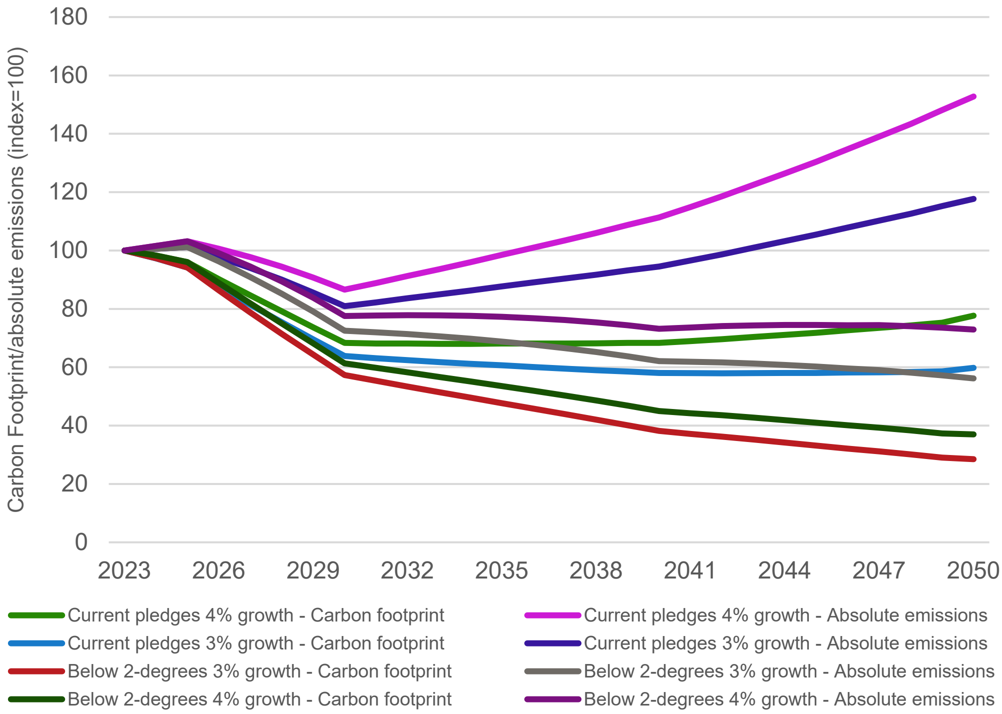
Sectoral assumptions

For each sector we obtain the pathway implied reduction. But this only indicates the emissions per unit of output. The total average output of the sector contributes in large part to the actual emissions produced by firms within that sector. To estimate future units of output, we used various sources to come up with annual output growth predictions. The outcome of absolute emission reduction is very sensitive to these estimates, as can be seen in the example for aviation below. The full overview of sector-based output growth assumptions and the related sources can be found in table 5.

Example: Aviation

To illustrate the concepts of decarbonization pathways above and the translation of output-based intensity to a carbon-footprint, we provide an example for the aviation sector. Figure 7 shows the carbon footprint calculated according to the outlined method above, indexed to 2023=100. To show sensitivity to growth assumptions, we show the carbon footprint pathway with both a 4% growth assumption (as used in the broader simulation) as well as a 3% growth assumption (1%-point lower). As can be seen, the carbon footprint drops in both the current pledges and below 2-degrees scenarios, regardless of growth, although only the below 2-degrees scenario leads to a pathway with a more than 50% carbon footprint decrease in 2050.

Figure 7: Carbon reduction pathways for aviation sector based on TPI data



Source: Aegon Asset Management, Transition Pathway Initiative (2024). Simulations for the period 2024-2035.

Because climate isn't affected by footprints, we also show absolute emission pathways for the aviation sector, calculated from the output-based intensity reductions in both scenario as well as unit-growth assumptions. An unpleasant surprise is found in the over 50% growth of absolute emissions when considering the current pledges scenario and a 4% growth assumption. We deem these assumptions realistic base point estimates. Although footprint decreases, we see growing absolute emissions, purely driven by growth of the aviation industry. The absolute emissions are very sensitive to the level of growth assumed. With 3% growth, absolute emissions still rise, albeit much lower. In the below 2-degrees scenario (which requires massive efforts and progress within the industry), we see a modest decrease of absolute emissions of about 28% from now until2050, even when assuming 4% growth.

Table 5: TPI sector specific pathway assumptions used in simulations

Sector	TPI-pathway output-based intensity metric	Output growth assumptions		Overall cumulative reduction absolute emissions (CO_2/ CO_{2e}) in 2025-2050 according to sector pathway	
		Annual % change	Source	(Inter)national pledges	Below 2 degrees
Airlines	Carbon intensity (gCO_2/ RTK)	4%	[11,12]	50.4%	-28.2%
Aluminium	Carbon intensity (tCO_{2e} / t aluminium)	4%	[13]	45.9%	-64.7%
Autos	Average new vehicle emissions (grams of CO_2 per kilometre [WLTP])	5%[14]	[15]	107.0%	-28.8%
Cement	Carbon intensity (tonnes of CO_2 per tonne of cementitious product)	0%	[16]	-11.0%	-68.7%
Diversified Mining	Carbon intensity (tonne CO_{2e}/ tonne copper equivalent)	2%	[17]	35.4%	-48.2%
Electricity Utilities	Carbon intensity (metric tonnes of CO_2 per MWh electricity generation)	1%	[18]	-37.8%	-100.0%
Oil & Gas	Emissions intensity (g CO_{2e} / MJ)	0%	[19,20]	-21.2%	-66.4%
Shipping	Carbon intensity (g CO_2 / t-km)	3%	[21]	50.6%	-46.8%
Steel	Carbon intensity (tonnes of CO_2 per tonne of steel)	1%	[22]	-0.2%	-57.8%
Non TPI-covered sectors	Tonnes of CO_{2e}/EVIC	See assumption 1.3, Table 4		-56.2%	-88.0%

[11] https://www.iata.org/en/pressroom/2024-releases/2024-06-03-01/

[12] https://www.iata.org/en/iata-repository/publications/economic-reports/global-outlook-for-air-transport-june-2024-report/

[13] https://international-aluminium.org/wp-content/uploads/2021/03/cm_2050_outlook_for_al_demand_20200528_4wycD18.pdf

[14] Based on point estimates of total travel demand for passenger cars by 2050 of 4.188 bln. and 2025 estimate of 1.107 bln. km. Rewritten to annual growth percentage of approx. 5%.

[15] https://www.statista.com/statistics/1399921/passenger-travel-demand-for-travel-by-passenger-cars-worldwide-non-urban

[16] https://www.worldcementassociation.org/blog/news/global-cement-industry-outlook-trends-and-forecasts

[17] https://www.miningweekly.com/article/association-unpacks-likely-copper-demand-trends-driving-growth-up-to-2040-2024-04-15

[18] https://www.mckinsey.com/industries/oil-and-gas/our-insights/energy-2050-insights-from-the-ground-up

[19] https://www.eia.gov/todayinenergy/detail.php?id=46656#

[20] https://prod.iea.org/reports/oil-market-report-april-2024

[21] https://maritime-executive.com/article/global-freight-demand-to-triple-by-2050

[22] https://www.oecd.org/en/topics/industry-business-and-entrepreneurship.html

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Appendix 3: Correlation matrix GICS daily sector returns

Correlation Matrix	Financials	Industrials	Health Care	Consumer Discretionary	Information Technology	Real Estate	Communication Services	Energy	Consumer Staples	Utilities	Materials
Financials	1.00	0.83	0.52	0.63	0.49	0.66	0.46	0.55	0.53	0.48	0.71
Industrials	0.83	1.00	0.52	0.67	0.57	0.68	0.49	0.44	0.53	0.47	0.75
Health Care	0.52	0.52	1.00	0.36	0.32	0.48	0.36	0.30	0.70	0.57	0.32
Consumer Discretionary	0.63	0.67	0.36	1.00	0.72	0.56	0.71	0.14	0.38	0.30	0.53
Information Technology	0.49	0.57	0.32	0.72	1.00	0.43	0.72	0.09	0.29	0.19	0.35
Real Estate	0.66	0.68	0.48	0.56	0.43	1.00	0.42	0.28	0.52	0.70	0.63
Communication Services	0.46	0.49	0.36	0.71	0.72	0.42	1.00	0.04	0.31	0.24	0.31
Energy	0.55	0.44	0.30	0.14		0.28	0.04	1.00	0.25	0.26	0.44
Consumer Staples	0.53	0.53	0.70	0.38	0.29	0.52	0.31	0.25	1.00	0.66	0.40
Utilities	0.48	0.47	0.57	0.30		0.70	0.24	0.26	0.66	1.00	0.44
Materials	0.71	0.75	0.32	0.53	0.35	0.63	0.31	0.44	0.40	0.44	1.00

Source: Bloomberg, Aegon Asset Management (2024).

Appendix 4: Mapping of sub-industries (GICS level 4) to high/low impact (NACE)

GICS Sub-Industry	GICS Code	Climate Impact	GICS Sub-Industry	GICS Code	Climate Impact
Oil & Gas Drilling	10101010	High	**Integrated Oil & Gas**	10102010	High
Oil & Gas Equipment & Services	10101020	High	**Oil & Gas Exploration & Production**	10102020	High
Commodity Chemicals	15101010	High	**Oil & Gas Refining & Marketing**	10102030	High
Diversified Chemicals	15101020	High	**Oil & Gas Storage & Transportation**	10102040	High
Fertilizers & Agricultural Chemicals	15101030	High	**Coal & Consumable Fuels**	10102050	High
Industrial Gases	15101040	High	**Construction Materials**	15102010	High
Specialty Chemicals	15101050	High	**Metal, Glass & Plastic Containers**	15103010	High
Paper & Plastic Packaging Products & Materials	15103020	High	**Aluminum**	15104010	High
Diversified Metals & Mining	15104020	High	**Copper**	15104025	High
Gold	15104030	High	**Precious Metals & Minerals**	15104040	High
Silver	15104045	High	**Steel**	15104050	High
Forest Products	15105010	High	**Paper Products**	15105020	High
Aerospace & Defense	20101010	High	**Building Products**	20102010	High
Construction & Engineering	20103010	High	**Electrical Components & Equipment**	20104010	High
Heavy Electrical Equipment	20104020	High	**Industrial Conglomerates**	20105010	Low
Construction Machinery & Heavy Transportation Equipment	20106010	High	**Agricultural & Farm Machinery**	20106015	High
Industrial Machinery & Supplies & Components	20106020	High	**Trading Companies & Distributors**	20107010	High
Commercial Printing	20201010	High	**Environmental & Facilities Services**	20201050	High
Office Services & Supplies	20201060	High	**Diversified Support Services**	20201070	Low
Security & Alarm Services	20201080	Low	**Human Resource & Employment Services**	20202010	Low
Research & Consulting Services	20202020	Low	**Data Processing & Outsourced Services**	20202030	Low
Air Freight & Logistics	20301010	High	**Passenger Airlines**	20302010	High
Marine Transportation	20303010	High	**Rail Transportation**	20304010	High
Cargo Ground Transportation	20304030	High	**Passenger Ground Transportation**	20304040	High
Airport Services	20305010	High	**Highways & Railtracks**	20305020	High
Marine Ports & Services	20305030	High	**Automotive Parts & Equipment**	25101010	High
Tires & Rubber	25101020	High	**Automobile Manufacturers**	25102010	High
Motorcycle Manufacturers	25102020	High	**Consumer Electronics**	25201010	High

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Home Furnishings	25201020	High	**Homebuilding**	25201030	High
Household Appliances	25201040	High	**Housewares & Specialties**	25201050	High
Leisure Products	25202010	High	**Apparel, Accessories & Luxury Goods**	25203010	High
Footwear	25203020	High	**Textiles**	25203030	High
Casinos & Gaming	25301010	Low	**Hotels, Resorts & Cruise Lines**	25301020	Low
Leisure Facilities	25301030	Low	**Restaurants**	25301040	Low
Education Services	25302010	Low	**Specialized Consumer Services**	25302020	Low
Distributors	25501010	High	**Broadline Retail**	25503030	High
Apparel Retail	25504010	High	**Computer & Electronics Retail**	25504020	High
Home Improvement Retail	25504030	High	**Other Specialty Retail**	25504040	High
Automotive Retail	25504050	High	**Homefurnishing Retail**	25504060	High
Self-Storage REITs	60108020	High	**Telecom Tower REITs**	60108030	High
Timber REITs	60108040	High	**Data Center REITs**	60108050	High
Drug Retail	30101010	High	**Consumer Staples Merchandise Retail**	30101040	High
Food Distributors	30101020	High	**Food Retail**	30101030	High
Brewers	30201010	High	**Distillers & Vintners**	30201020	High
Soft Drinks & Non-alcoholic Beverages	30201030	High	**Agricultural Products & Services**	30202010	High
Packaged Foods & Meats	30202030	High	**Tobacco**	30203010	High
Household Products	30301010	High	**Personal Care Products**	30302010	High
Health Care Equipment	35101010	High	**Health Care Supplies**	35101020	High
Health Care Distributors	35102010	High	**Health Care Services**	35102015	Low
Health Care Facilities	35102020	Low	**Managed Health Care**	35102030	Low
Health Care Technology	35103010	Low	**Biotechnology**	35201010	Low
Pharmaceuticals	35202010	High	**Life Sciences Tools & Services**	35203010	High
Diversified Banks	40101010	Low	**Regional Banks**	40101015	Low
Diversified Financial Services	40201020	Low	**Multi-Sector Holdings**	40201030	Low
Specialized Finance	40201040	Low	**Commercial & Residential Mortgage Finance**	40201050	Low
Transaction & Payment Processing Services	40201060	Low	**Consumer Finance**	40202010	Low
Asset Management & Custody Banks	40203010	Low	**Investment Banking & Brokerage**	40203020	Low
Diversified Capital Markets	40203030	Low	**Financial Exchanges & Data**	40203040	Low
Mortgage REITs	40204010	Low	**Insurance Brokers**	40301010	Low
Life & Health Insurance	40301020	Low	**Multi-line Insurance**	40301030	Low
Property & Casualty Insurance	40301040	Low	**Reinsurance**	40301050	Low
IT Consulting & Other Services	45102010	Low	**Internet Services & Infrastructure**	45102030	Low
Application Software	45103010	Low	**Systems Software**	45103020	Low
Communications Equipment	45201020	High	**Technology Hardware, Storage & Peripherals**	45202030	High
Electronic Equipment & Instruments	45203010	High	**Electronic Components**	45203015	High

Electronic Manufacturing Services	45203020	High	**Technology Distributors**	45203030	High
Semiconductor Materials & Equipment	45301010	High	**Semiconductors**	45301020	High
Alternative Carriers	50101010	Low	**Integrated Telecommunication Services**	50101020	Low
Wireless Telecommunication Services	50102010	Low	**Advertising**	50201010	Low
Broadcasting	50201020	Low	**Cable & Satellite**	50201030	Low
Publishing	50201040	Low	**Movies & Entertainment**	50202010	Low
Interactive Home Entertainment	50202020	Low	**Interactive Media & Services**	50203010	Low
Electric Utilities	55101010	High	**Gas Utilities**	55102010	High
Multi-Utilities	55103010	High	**Water Utilities**	55104010	High
Independent Power Producers & Energy Traders	55105010	High	**Renewable Electricity**	55105020	High
Diversified REITs	60101010	High	**Industrial REITs**	60102510	High
Hotel & Resort REITs	60103010	High	**Office REITs**	60104010	High
Health Care REITs	60105010	High	**Multi-Family Residential REITs**	60106010	High
Single-Family Residential REITs	60106020	High	**Retail REITs**	60107010	High
Other Specialized REITs	60108010	High	**Diversified Real Estate Activities**	60201010	High
Real Estate Operating Companies	60201020	High	**Real Estate Development**	60201030	High
Real Estate Services	60201040	High			

Source: S&P Global, S&P Global NACE-to-GICS Sub-Industry Climate impact mapping

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