

EU Climate Benchmarks

Index Construction Matters

Ben Leale-Green

Portfolio Strategist
Systematic Equity Beta

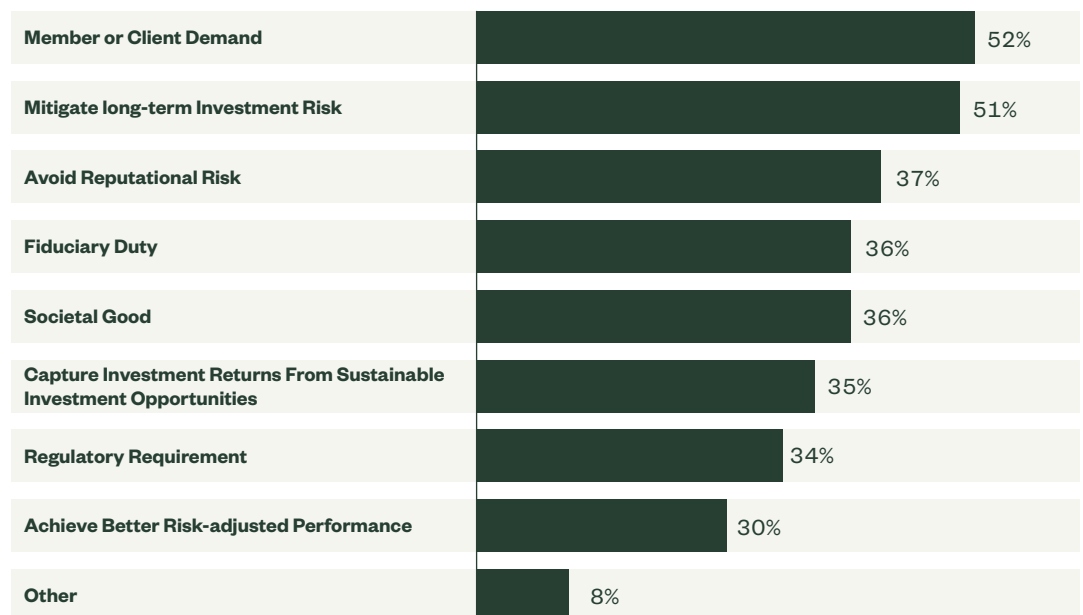
In our recent papers, we discussed the standards and implications of Climate Transition Benchmarks (CTB) and Paris-Aligned Benchmarks (PAB), and what to consider when choosing between them.* The EU defined these climate benchmarks to establish minimum standards for indices to align with IPCC's 1.5°C trajectory and net zero in 2050.

Current index offerings can be best understood collectively as climate strategies that comply with PAB or CTB minimum standards, rather than all PABs being the same, and all CTBs being alike: they can also vary by index design, active exposures and return profile (see Appendix 1 for details). In this paper, we assess standard 'off-the-shelf' index offerings from S&P, MSCI, FTSE and Solactive, those most readily accessible to investors. Of course, there are other indices in the market and many providers are open to customised index solutions.

Index Design Inputs: EU Climate Benchmarks Are Built Differently

There are many ways in which climate indices can be built, including the input data (how companies are assessed from a climate perspective) and index construction (how the data is practically utilised to yield an index). These differences are for good reason: investors have different rationale and motivation for implementing sustainable investments (see Figure 1) and therefore different portfolio objectives. Differences in index design often aim to meet different portfolio objectives, or combinations of these. Arguably, this is a benefit of the regulation, which sets standards while allowing room for innovation and meeting a variety of goals.

Figure 1
Differing Rationale
for Implementing
Sustainable
Investment



Source: FTSE Russell, 2023 global survey findings from asset owners. Data as of 2023. Chart for illustrative purposes.

* EU Climate Benchmarks: Standards and Implications (ssga.com) and EU Climate Benchmarks: Paris Aligned or Climate Transition? (ssga.com).

From an input standpoint (see Figure 2 for summary and Appendices 4 & 5 for further details), the Solactive and MSCI overlay indices largely aim to meet the minimum requirements laid out by the EU (see Appendix 2).¹ This is a different approach from the S&P and FTSE indices, alongside the MSCI PAB and MSCI Climate Change indices, each of which measures companies with metrics that go beyond the minimum regulatory standards. These include green revenues, which the regulation deems ‘voluntary’, measures assessing the forward-looking climate pathways (as recommended by many investor bodies and others),² and the physical risks companies may face from climate change. Additional metrics can yield a more nuanced view of companies’ climate risks, impacts and opportunities, similar to how fundamental analysts may look at a scorecard or range of metrics in assessing companies,³ rather than purely relying on carbon intensity.

A major difference between providers, and even within a provider’s own offerings, is the index construction method used. Some use more transparent tilted methods, such as the FTSE indices and the MSCI Climate Change Index series, while the MSCI PAB and overlay index series minimise tracking error through an optimisation process. Tracking error measures the difference in return between a strategy and its benchmark or parent index, measuring the volatility of excess return.⁴ The S&P and Solactive indices strike a middle ground and utilise the power of optimisation, albeit in different ways that do not use a risk model to estimate tracking error. More transparent weight allocations can help users better understand why companies receive the weight they do, potentially benefiting understanding of the indices. Transparent allocations would often receive a higher correlation between the active weights companies receive and the input data, which may be more suitable if the goal is to create real-world impact through capital allocation mechanisms. However, the lower tracking error generally observed from tracking error minimisation can often supersede the need for increased transparency.

Figure 2

EU Climate Benchmarks Are Not Built Equally

	Solactive PAB	S&P PAB	FTSE PAB	MSCI PAB	MSCI PAB Overlay
Qualitative Understanding	Meet PAB minimum standards through controlled transparent reweighting	Beyond PAB minimum and voluntary standards through controlled transparent reweighting	Beyond PAB minimum and voluntary standards through transparent reweighting	Beyond PAB minimum and voluntary standards with minimal active risk	Meet PAB minimum standards with minimal active risk
7% y-o-y Decarbonisation Pathway	✓	✓	✓	10%	✓
Green Revenues	✗	✓	✓	✓	✗
Physical Risk	✗	✓	✗	✓	✗
Forward Looking Scenario Alignment	✗	1.5°C	Tilts towards	✗*	✗
Fossil Fuel Reserves	✗	✓	✓	✓	✗
Index Construction	Active weight optimisation	Proportional active weight optimisation with country & sector penalties	Tilt	Min tracking error optimisation	Min tracking error optimisation

Source: S&P, MSCI, FTSE, Solactive, State Street Global Advisors, 31 July 2023.

*Forward-looking scenario analysis to be implemented within the MSCI PAB in 2024. Chart for illustrative purposes.

Figure 2

EU Climate Benchmarks Are Not Built Equally (Cont'd)

	Solactive CTB	S&P CTB	FTSE CTB	MSCI Climate Change	MSCI CTB Overlay
Qualitative Understanding	Meet CTB minimum standards through controlled transparent reweighting	Beyond CTB minimum and voluntary standards through controlled transparent reweighting	Beyond CTB minimum and voluntary standards through transparent reweighting	Beyond CTB minimum and voluntary standards through transparent reweighting	Meet CTB minimum standards with minimal active risk
7% y-o-y Decarbonisation Pathway	✓	✓	✓	✓	✓
Green Revenues	✗	No worse	✓	No worse constraint & tilts towards via low carbon transition score	✗
Physical Risk	✗	✓	✗	✗	✗
Forward Looking Scenario Alignment	✗	1.5°C	Tilt towards	✗	✗
Fossil Fuel Reserves	✗	No worse	✓	✗	✗
Index Construction	Active weight optimisation	Proportional active weight optimisation with country & sector penalties	Tilt	Tilt	Min tracking error optimisation

Source: S&P, MSCI, FTSE, Solactive, State Street Global Advisors, 31 July 2023.

*Forward-looking scenario analysis to be implemented within the MSCI PAB in 2024. Chart for illustrative purposes.

Active Exposures: Index Design Differences Drive Divergent End Results

When indices share the same minimum regulatory standards, even if they're built differently, how much can they really differ? The answer: quite a lot. We see this in multiple areas related to climate and other considerations within portfolios, such as active risk and concentration (see Exhibit 3).

For example, the FTSE indices tend to overweight companies with green revenues to a large extent, gaining close to three times the exposure, while the Solactive indices do not explicitly incorporate green revenues and actually see a tilt away from them. In contrast, the MSCI overlay indices do not control for green revenues but still show an improvement nonetheless.

Figure 3

EU Climate Benchmarks Outcomes Are Not Equal⁵**Paris Aligned Benchmarks**

	MSCI World	Solactive PAB	S&P PAB	FTSE PAB	MSCI PAB	MSCI PAB Overlay
1y Annualised Return (%)	5.62	5.63	6.21	6.38	4.17	4.57
1y Annualised Volatility (%)	14.74	13.88	15.27	15.25	15.43	14.88
1y Tracking Error (%)	—	2.20	2.07	2.66	2.09	1.18
Effective # Stocks	132.62	133.61	104.22	51.40	101.73	129.20
Weight top 10 Stocks (%)	20.09	18.93	23.67	36.60	22.43	20.42
Carbon Intensity	306.82	122.21	93.30	109.23	100.00	104.88
Green Revenue	3.56	2.73	4.44	9.81	5.52	4.56
Oil & Gas (%)	6.08	0.11	0.83	1.11	0.18	0.59
Thermal Coal (%)	0.79	0.00	0.00	0.72	0.00	0.10

Source: S&P, MSCI, FTSE, Solactive, ISS, State Street Global Advisors, 31 July 2023. Carbon Intensity data used is from ISS, Green revenues from FTSE Russell, and Oil & Gas and Thermal coal are the State Street Global Advisors POV screen definitions. This data may differ from the data used within the indices. Chart for illustrative purposes.

Figure 3

EU Climate Benchmarks Outcomes Are Not Equal⁵ (Cont'd)

Climate Transition Benchmarks

	MSCI World	Solactive CTB	S&P CTB	FTSE CTB	MSCI Climate Change	MSCI CTB Overlay
1y Annualised Return (%)	5.62	5.81	6.54	5.90	7.21	4.93
1y Annualised Volatility (%)	14.74	13.91	15.02	15.26	16.12	14.81
1y Tracking Error (%)	—	1.68	1.25	2.46	2.96	0.56
Effective # Stocks	132.62	133.46	113.06	56.25	71.49	131.05
Weight top 10 Stocks (%)	20.09	18.94	22.14	33.97	28.91	20.28
Carbon Intensity	306.82	164.75	127.41	147.27	156.13	153.58
Green Revenue	3.56	2.73	3.97	9.60	7.36	4.15
Oil & Gas (%)	6.08	3.81	5.13	3.16	0.99	3.67
Thermal Coal (%)	0.79	0.82	0.17	0.84	0.20	0.13

Source: S&P, MSCI, FTSE, Solactive, ISS, State Street Global Advisors, 31 July 2023. Carbon Intensity data used is from ISS, Green revenues from FTSE Russell, and Oil & Gas and Thermal coal are the State Street Global Advisors POV screen definitions. This data may differ from the data used within the indices. Chart for illustrative purposes.

Beyond the climate characteristics, we purposely focus more on active exposures rather than performance, given there is no obvious significant alpha⁶ since launch (see Appendix 7⁷). To illustrate the impact index design can have on tracking error, we can compare the MSCI CTB Overlay and the MSCI Climate Change indices. Both comply with the CTB label and use the same data sources, but differences in the index construction method and the incorporation of other objectives beyond the CTB standards leads to strikingly different results. The MSCI CTB Overlay index can be interpreted as an approximation of the lowest tracking error possible while meeting the CTB label.⁸ Alternatively, the MSCI Climate Change uses a tilted methodology and has objectives beyond the regulatory minimum standards.

The MSCI Climate Change index had over five times the tracking error⁹ of the MSCI CTB Overlay index, resulting in a very different active return potential. Historically, the MSCI Climate Change Index had a maximum active return over a six-month period of 710 basis points (bps), eight times that of the MSCI CTB Overlay, with a maximum active return of 88 bps over any six-month period since the end of 2016 (see Appendix 9 for visualisation). The role of the index construction is also evident when comparing the S&P CTB which has even more ambitious climate objectives than the MSCI Climate Change index. Despite this, the S&P CTB has a significantly lower tracking error (less than half) than the MSCI Index. This shows how decisions related to index construction and the inclusion of insights beyond the minimum standards can cause meaningfully different exposures and performance outcomes.

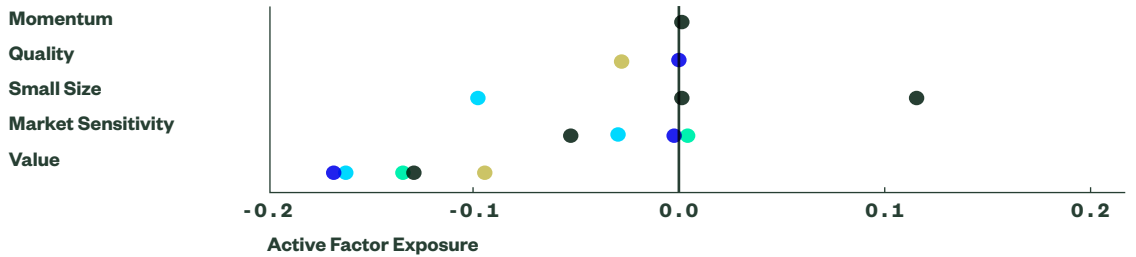
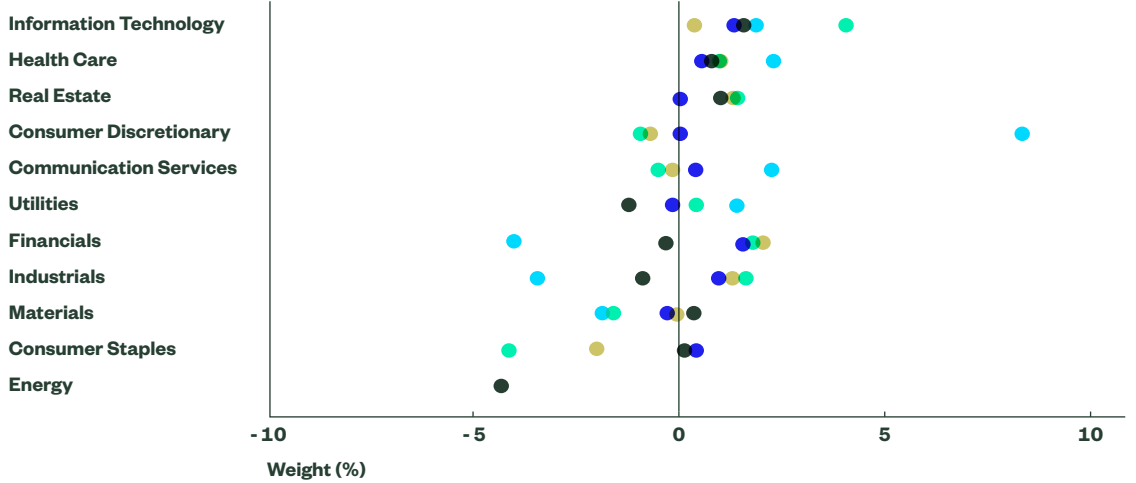
With respect to index construction, we understand generally that tracking error minimisation helps to control active risk (as used within the MSCI CTB Overlay indices) efficiently per unit of active exposure. This is challenging to manage to the same extent with a simpler tilted framework, as shown by State Street Global Advisors research.¹⁰

Generally speaking, the indices active sector and factor allocations are directionally similar. Across all indices, both PAB and CTB, they are underweight the energy sector and overweight tech, with a growth (negative value) tilt (see Exhibit 4). However, the magnitudes of these active positions are very different. S&P Indices tend to take the lowest active sector positions, with an average active sector weight of less than 30 bps for their CTB and around 1% for the PAB, while the FTSE indices take a 3% and 3.6% average absolute sector weights for their respective EU Climate Benchmark classes. Again, the portfolio construction likely plays a significant role here, where S&P minimise active sector weights directly, while the tilted methodology employed by FTSE and the MSCI Climate Change index don't have these features.

Two areas where indices also diverge noticeably are in their consumer discretionary sector and size exposures. For example, the FTSE indices show a large overweight in the consumer discretionary sector, while most others show neutral to underweight positions. This is primarily caused by very large active positions in a couple of large names, rather than the average company being overweighted. Differences in size exposure are likely driven by the portfolio construction method. Tilted indices tend to a large size bias, whereas indices utilising active share from Solactive tilt towards smaller-cap stocks. These takeaways are consistent and as one may expect, but illustrate the importance of index construction. Not all PABs are the same, nor are all CTBs.

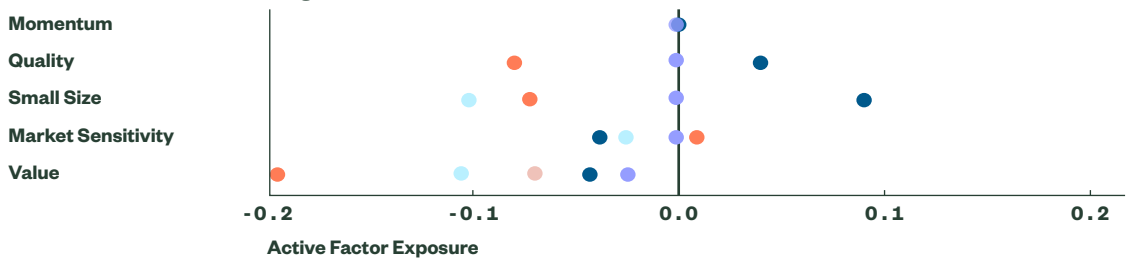
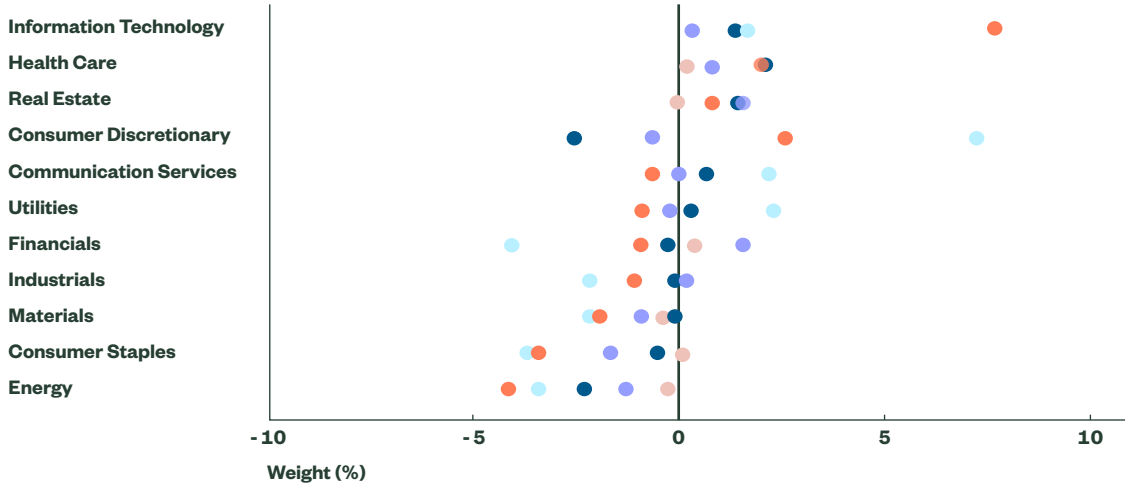
Figure 4
Active Allocations
Are Directionally
Similar, But Varied
 Paris Aligned
 Benchmarks

- Solactive PAB
- MSCI PAB
- S&P PAB
- MSCI PAB Overlay
- FTSE PAB



Climate Transition
 Benchmarks

- Solactive CTB
- MSCI Climate Change
- S&P CTB
- MSCI CTB Overlay
- FTSE CTB



Source: S&P, MSCI, FTSE, Solactive, Kenneth French Data Library, State Street Global Advisors, data as of 31 July 2023 for the active sector allocations and from 1 August 2022 to 31 July 2023 for the active factor exposures. Sector allocations are based on GICS sectors. Chart for illustrative purposes.

Another useful area to note is that tracking error may increase over time, particularly if the parent index fails to decarbonise (see our paper, [EU Climate Benchmarks Standards and Implications](#), for further details). Under these conditions, we would likely also see increased active sector and factor exposures.

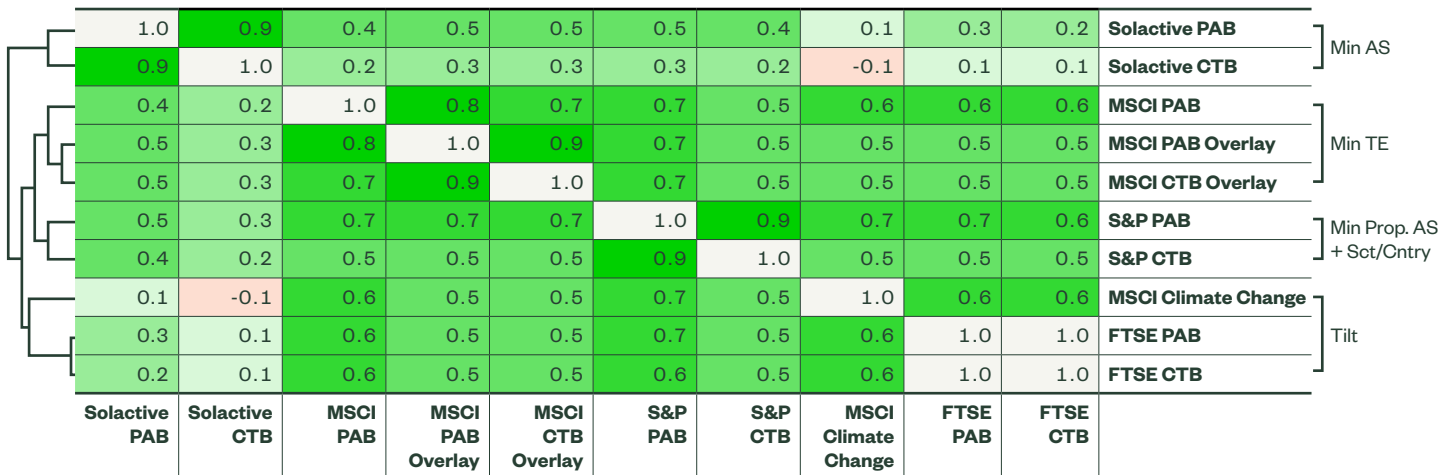
Index Return Profile: Maybe Not As We Would Expect

While we see that active sector and factor exposures tend to be directionally similar across EU Climate Benchmark aligned indices, with varying levels of active risk, what is the difference in the indices' return profile? Specifically, we consider whether EU Climate Benchmark aligned indices have similar return characteristics to each other; whether PABs across providers show returns that are distinct from CTBs; if index construction methods yield characteristics specific to that method; and whether the index provider (including the data they use) affect the pattern of return.

To answer these questions, we assess the correlations of excess returns.¹¹ In the graphic below we 'cluster'¹² the correlations — a process that helps to break down the indices into smaller groups that have similarities in their return profile. On the left-hand side of Figure 5, we can see a graphic that displays these clusters as a hierarchy or a tree-like structure. Where the vertical line is further to the right, it represents two indices (such as the two FTSE indices at the bottom) that have a more similar return profile. The inverse is also true.

Figure 5

Index Construction May Better Explain Return Profile Than PAB or CTB Alignment



Source: S&P, MSCI, FTSE, Solactive, State Street Global Advisors, data from 1 August 2022 to 31 July 2023. The acronyms on the right hand side of the chart refer to the index construction methods. Min AS: minimise active share, Min TE: minimise tracking error, Min prop. AS + Sct/Cntry: minimise active weights proportionally to the parent weight, with country and sector penalties and tilt: tilted. Chart for illustrative purposes. Past performance is not a reliable indicator of future performance.

We see that EU Climate Benchmarks, with the exception of the Solactive CTB and MSCI Climate Change indices, are directionally similar showing a positively correlated excess return. Within this universe, the Solactive indices appear to differ the most from other indices, possibly due to their index construction method and factor exposures that diverge from other providers.

Interestingly, among the indices analysed, the index construction method (i.e. optimisation or tilting) had more similarities versus the PAB or CTB classification 'label.' Clustering indices in this way suggests that two indices with the same portfolio construction method may be most similar, which cannot be said for PABs or CTBs.

Unfortunately, it is not easy to separate what is specific to an index provider and portfolio construction method, given that S&P and Solactive use methods that are unique to them. However, MSCI use both tilting and tracking error minimisation, with their tilted methodology (MSCI Climate Change) appearing more similar to the FTSE tilt than to their other indices that minimise tracking error. This further highlights the importance of an index construction technique when assessing the return outcome of EU Climate Benchmarks.

The Bottom Line

Investors have an abundance of choice when it comes to selecting EU Climate Benchmark aligned indices. Given the differences noted, indices should be thought of as climate strategies adhering to PAB or CTB minimum standards, rather than being looked at uniformly as a PAB or a CTB. This is evidenced in the index design inputs, such as index construction method and data leveraged, as well as in the active exposures (i.e. sector and factor allocations), and the pattern of returns over time. This in turn means selecting the 'right' index to meet specified goals is important.

In our next paper in this series we examine some of the key considerations around differences in index design inputs and portfolio construction methods that investors can apply when selecting the right index to meet their climate goals and objectives.

Appendix

Appendix 1: Indices Assessed

Abbreviated Index Name	Official Index Name	Index Provider	EU Benchmark
Solactive PAB	Solactive ISS ESG Developed Markets Paris-Aligned Benchmark Index	Solactive	PAB
Solactive CTB	Solactive ISS ESG Developed Markets Climate Transition Benchmark Index	Solactive	CTB
S&P PAB	S&P Developed Ex-Korea LargeMidCap Net Zero 2050 Paris-Aligned ESG Index	S&P Dow Jones Indices	PAB
S&P CTB	S&P Developed Ex-Korea LargeMidCap Net Zero 2050 Climate Transition ESG Index	S&P Dow Jones Indices	CTB
MSCI PAB	MSCI World Climate Paris Aligned Index	MSCI	PAB
MSCI PAB Overlay	MSCI World EU PAB Overlay Index	MSCI	PAB
MSCI Climate Change	MSCI World Climate Change Index	MSCI	CTB
MSCI CTB Overlay	MSCI World EU CTB Overlay Index	MSCI	CTB
FTSE PAB	FTSE Developed ex Korea ex Poland Paris-aligned (PAB) Index	FTSE Russell	PAB
FTSE CTB	FTSE Developed ex Korea ex Poland Climate Transition (CTB) Index	FTSE Russell	CTB

Source: S&P, MSCI, FTSE, Solactive, State Street Global Advisors, 30 June 2023.

Appendix 2: EU Climate Benchmark Minimum Standards

Minimum Standards	EU Climate Transition Benchmark (CTB)	EU Paris Aligned Benchmark (PAB)
Risk oriented minimum standards		
Minimum Scope 1+2(+3) carbon intensity reduction compared to investable universe	30%	50%
Scope 3 phase-in	Up to 4 years from 23rd December 2020	
Baseline Exclusions	Controversial Weapons Societal norms violators ¹⁴ Tobacco	
Activity Exclusions	No	Coal (1%+ revenues) Oil (10%+ revenues) Natural Gas (50%+ revenues) Electricity producers with carbon intensity of lifecycle GHG emissions higher than 100gCO ₂ e/kWh (50%+ revenues)
Opportunity oriented minimum standards		
Year-on-year self-decarbonisation of the benchmark	At least 7% on average per annum: in line with or beyond the decarbonisation trajectory from the IPCC's 1.5°C scenario (with no or limited overshoot)	
Minimum green share/brown share ratio compared to investable universe (voluntary)	At least equivalent	Significantly larger (factor 4)
Exposure constraints	Minimum exposure to sectors highly exposed to climate change issues is at least equal to equity market benchmark value	
Corporate Target Setting (voluntary)	Weight increase shall be considered for companies which set evidence-based targets under strict conditions to avoid greenwashing (see Article 9 in section 5.12 re conditions)	
Disqualification from label if 2 consecutive years of misalignments with trajectory	Immediate	
Relevance oriented minimum standards		
Review Frequency	Minimum requirements shall be reviewed every three years to recognise market development as well as technological and methodological progress.	

Source: Official Journal of the European Union (2020) & EU TEG Final Report, (2019).

Appendix 3: Indices Assessed

Criteria	PAB Requirement	Solactive PAB	S&P PAB	FTSE PAB	MSCI PAB	MSCI PAB Overlay
Carbon intensity reduction	50%	50%	50% + 5% Buffer	50% + 0.5% Buffer	50%	50%
Decarbonisation	7% y-o-y (inflation adjusted)	7%	7%	7%	10%	7%
Carbon measure	Scope 1+2(+3)/EVIC (scope 3 phased in over time)	Scope 1+2+3/EVIC	Scope 1+2+3/EVIC	Scope 1+2(+3 phased in)/EVIC	Scope 1+2+3/EVIC	Scope 1+2+3/EVIC
Baseline exclusions	Controversial Weapons Societal norms violations Tobacco	Controversial Weapons Societal norms violations Tobacco	Controversial Weapons Societal norms violations (UNGC & ESG Controversies) Tobacco	Controversial Weapons Tobacco	Controversial Weapons Societal norms violations (ESG & Environmental Controversies) Tobacco	Controversial Weapons Societal norms violations (ESG & Environmental Controversies) Tobacco
Activity exclusions	1% Coal 10% Oil 50% Natural Gas 50% Highly Intensive Electricity Production	1% Coal 10% Coal, Oil & Gas 50% Highly Intensive Electricity Production	1% Coal 10% Oil 50% Natural Gas 50% Highly Intensive Electricity Production	1% Coal 10% Oil 50% Natural Gas 50% Highly Intensive Electricity Production	1% Coal 10% Oil & Natural Gas 50% Highly Intensive Electricity Production	1% Coal 10% Oil & Natural Gas 50% Highly Intensive Electricity Production

Criteria	PAB Requirement	Solactive PAB	S&P PAB	FTSE PAB	MSCI PAB	MSCI PAB Overlay
Further exclusions		SDGs 12, 13, 14, 15: Significant negative impact	Small arms Military contracting Thermal coal power generation Oil sands Shale energy Gambling Alcohol	Oil sands		
Exposure to High Climate Impact NACE Sectors	No Lower than parent	No Lower than parent	No Lower than parent	No Lower than parent	No Lower than parent	No Lower than parent
Green/Brown (voluntary)	4x		4x		4x	
Green revenue				100% increase	100% Increase	
Corporate target setting (voluntary)	Weight increase for companies with Science Based Targets	Increase	20% increase		20% increase	
Fossil fuel reserves			80% decrease	50% decrease	50% decrease	
Carbon Transition Score					Reduction in low carbon transition score by 10%	
Carbon Governance Score				TPI MQ 0.2 std increase		
Climate VaR					Max(0, Aggregate Climate VaR of Parent Index)	
Physical risk			Score based: 10% decrease & max stock weight capping curve		VaR based: 50% reduction	
Forward looking scenario alignment			1.5°C	TPI carbon performance tilt towards best and away from worst (tilt factor 1). Exclude companies with not aligned emissions reductions.	Implied Temperature Rise to be implemented in 2024.	
ESG score improvement			Underlying index waESG after 20% of the lowest ESG scoring stocks by count are removed and their weight redistributed			
ESG/Climate data quality cap			weight of non-disclosing carbon companies 1.1x parent weight cap	ICB bank sub-sector companies capped at parent weight		
Data providers		ISS	S&P Global ESG, S&P Global Trucost, Sustainalytics	FTSE, TPI, Sustainalytics	MSCI	MSCI
Portfolio construction		Minimise active weights	Minimise proportional active weight optimisation with country & sector penalties	Tilted	Minimise ex-ante tracking error	Minimise ex-ante tracking error
Rebalance frequency			Quarterly	Annual	Semi-Annual	Semi-Annual
Sector constraint		Min(5% and half of the weight of the sector)+- if cannot be met, constrain minimum sector weight as sum of eligible weight within the sector		5%+-	5%+- (except Energy)	5%+- (except Energy)

Criteria	PAB Requirement	Solactive PAB	S&P PAB	FTSE PAB	MSCI PAB	MSCI PAB Overlay
Country constraint				5%+-	5%+-	5%+-
Company/constituent level constraint		0.5%+- (constituent level)	2%+- (Company level)		2%+- (constituent level)	2%+- (constituent level)
Company minimum weight		0.01% (included rather than removed)	Existing constituents: $\geq 0.01\%$ New constituents: $\geq \max(0.01\%, \min(0.05, 0.5 \times \text{underlying stock weight}))$	0.05%	0.01%	
Company max weight		5%	max(5%, underlying company weight)	5%		
Max weight multiple				20x	20x	20x
Effective n				25% parent		
Liquidity cap			Capped at the company level based on 5 hypothetical days to sell, with 10% participation using 3-month MDVT for a 1bn USD notional			
Beta constraint				0.7-1.3		
Turnover constraint					5% one-way	5% one-way
Common factor risk aversion					0.0075	0.0075
Specific risk aversion					0.075	0.075

Source: S&P, MSCI, FTSE, Solactive, State Street Global Advisors, 30 June 2023.

Appendix 4: CTB Aligned Indices Further Details

Criteria	CTB Requirement	Solactive CTB	S&P CTB	FTSE CTB	MSCI Climate Change	MSCI CTB Overlay
Carbon intensity reduction	30%	30%	30% + 5% Buffer	30% + 0.5% Buffer	30%	30%
Decarbonisation	7% y-o-y (inflation adjusted)	7%	7%	7%	7%	7%
Carbon measure	Scope 1+2(+3)/EVIC (scope 3 phased in over time)	Scope 1+2+3/EVIC	Scope 1+2+3/EVIC	Scope 1+2(+3 phased in)/EVIC	Scope 1+2+3/EVIC	Scope 1+2+3/EVIC
Baseline exclusions	Controversial Weapons Societal norms violations Tobacco	Controversial Weapons Societal norms violations Tobacco	Controversial Weapons Societal norms violations (UNGC & ESG Controversies) Tobacco	Controversial Weapons Tobacco	Controversial Weapons Societal norms violations (ESG & Environmental Controversies) Tobacco	Controversial Weapons Societal norms violations (ESG & Environmental Controversies) Tobacco
Further exclusions		SDGs 12, 13, 14, 15: Significant negative impact		Thermal coal Oil sands	Thermal coal mining	
Exposure to High Climate Impact NACE Sectors	No Lower than parent	No Lower than parent	No Lower than parent	No Lower than parent	No Lower than parent	No Lower than parent
Green/Brown	No Lower than parent		No Lower than parent		No Lower than parent	
Green revenue				100% increase	100% Increase	
Corporate target setting	Weight increase for companies with Science Based Targets	No Lower than parent	No Lower than parent		No Lower than parent	

Criteria	CTB Requirement	Solactive CTB	S&P CTB	FTSE CTB	MSCI Climate Change	MSCI CTB Overlay
Fossil fuel reserves			No Lower than parent	30% decrease	50% decrease	
Carbon Transition Score					Tilts towards	
Carbon Governance Score				TPI MQ 0.2 std increase		
Physical risk			Score based: no lower than parent & max stock weight capping curve			
Forward looking scenario alignment			1.5°C	TPI carbon performance tilt towards best and away from worst (tilt factor 1). 60% emissions reductions of companies with not aligned emissions reductions.		
ESG score improvement			No Lower than parent			
ESG/Climate data quality cap			weight of non-disclosing carbon companies 1.1x parent weight cap	ICB bank sub-sector companies capped at parent weight		
Data providers		ISS	S&P Global ESG, S&P Global Trucost, Sustainalytics	FTSE, TPI, Sustainalytics	MSCI	MSCI
Portfolio construction		Minimise active weights	Minimise proportional active weight optimisation with country & sector penalties	Tilted	Tilted	Minimise ex-ante tracking error
Rebalance frequency			Quarterly	Annual	Semi-Annual	Semi-Annual
Sector constraint		Min(5% and half of the weight of the sector)+-if cannot be met, constrain minimum sector weight as sum of eligible weight within the sector		5%+-		5%+- (except Energy)
Country constraint				5%+-		5%+-
Company/constituent level constraint		0.5%+- (constituent level)	2%+- (Company level)			2%+- (constituent level)
Company minimum weight		0.01% (included rather than removed)	Existing constituents: $\geq 0.01\%$ New constituents: $\geq \max(0.01\%, \min(0.05, 0.5 \times \text{underlying stock weight}))$	0.05%		
Company max weight		5%	max(5%, underlying company weight)	5%		
Max weight multiple				20x		20x
Effective n				25% parent		
Liquidity cap			Capped at the company level based on 5 hypothetical days to sell, with 10% participation using 3-month MDVT for a 1bn USD notional			

Criteria	CTB Requirement	Solactive CTB	S&P CTB	FTSE CTB	MSCI Climate Change	MSCI CTB Overlay
Beta constraint				0.7-1.3		
Turnover constraint						5% one-way
Common factor risk aversion						0.0075
specific risk aversion						0.075

Source: S&P, MSCI, FTSE, Solactive, State Street Global Advisors, 30 June 2023.

Appendix 5: Performance Attribution Model Specification

Factor	Factor Exposure	Source
Beta	Market Beta	MSCI & Kenneth French Data Library
High minus Low (HML)	Value	Kenneth French Data Library
Small minus Big (SMB)	Small Size	Kenneth French Data Library
Robust minus Weak (RMW)	Quality	Kenneth French Data Library
Winners minus Losers (WML)	Momentum	Kenneth French Data Library

Source: MSCI & Kenneth French Data Library. Chart for Illustrative Purposes.

The performance attribution model is specified as:

$$r_{it} - r_{ft} = \alpha_{it} + \beta_{im}(r_{mt} - r_{ft}) + \beta_{is}SBM_t + \beta_{ih}HML_t + \beta_{ir}RMW_t + \beta_{iw}WML_t + \varepsilon_{it}$$

Where $r_{it} - r_{ft}$ is the excess return over the risk-free rate for index i at time t , α_{it} is alpha, $\beta_{im}(r_{mt} - r_{ft})$ is the index sensitivity to the MSCI World Index minus the risk-free rate, $\beta_{is}SBM_t$ is the index sensitivity to the small size factor, $\beta_{ih}HML_t$ is the index sensitivity to the value factor, $\beta_{ir}RMW_t$ is the index sensitivity to the quality factor, $\beta_{iw}WML_t$ is the index sensitivity to the momentum factor, and ε_{it} is the model error.

Appendix 6: Performance Attribution 1 Year

	Solactive PAB	S&P PAB	FTSE PAB	MSCI PAB	MSCI PAB Overlay	Solactive CTB	S&P CTB	FTSE CTB	MSCI Climate Change	MSCI CTB Overlay
Alpha	0.0001	0	0	-0.0001	0	0.0001	0	-0.0001	0	0
Beta	0.9316***	0.9884***	0.9597***	1.0092***	0.9900***	0.9508***	0.9961***	0.9673***	1.0102***	0.9965***
Small Size	0.1317***		-0.1288***			0.1174***		-0.1325***	-0.0937***	
Value	-0.1171***	-0.1755***	-0.1597***	-0.1299***	-0.0713***	-0.0550***	-0.0899***	-0.1372***	-0.2150***	-0.0332***
Quality					-0.0363**	0.0519***			-0.1036***	
R-squared Adj.	0.9888	0.9941	0.9814	0.9891	0.9957	0.9928	0.9965	0.9835	0.9862	0.999
N.obs	256	256	256	256	256	256	256	256	256	256

Source: MSCI & S&P, FTSE, Solactive & Kenneth French Data Library. Data as of 31 July 2023. Chart for Illustrative Purposes.

Appendix 7:
Performance Attribution
Live History

	Solactive PAB	S&P PAB	FTSE PAB	MSCI PAB	MSCI PAB Overlay	Solactive CTB	S&P CTB	FTSE CTB	MSCI Climate Change	MSCI CTB Overlay
Alpha	0	0	0	0	0	0	0	0	0	0
Beta	0.9504***	1.0046***	0.9584***	1.0028***	0.9991***	0.9575***	1.0119***	0.9617***	1.0097***	0.9993***
Small Size	0.1053***		-0.0838***			0.0765***		-0.0868***	-0.0382***	
Value	-0.0680***	-0.1458***	-0.0576***	-0.1020***	-0.0432***	-0.0223***	-0.1196***	-0.0395***	-0.1394***	-0.0185***
Quality	0.0738***		0.1112***			0.0702***		0.1129***	-0.0311***	
Momentum	-0.0253***		-0.0473***	-0.0263***	-0.0158***	-0.0184***	0.0171***	-0.0487***	-0.0349***	-0.0086***
R-squared Adj.	0.9889	0.9911	0.9813	0.9891	0.9955	0.9934	0.994	0.9832	0.9934	0.9991
N.obs	445	555	452	710	538	618	555	452	1061	538

Source: MSCI &, S&P, FTSE, Solactive & Kenneth French Data Library. Data as of 31 July 2023. Chart for Illustrative Purposes.

Appendix 8:
Performance
Attribution Since
31st December 2016

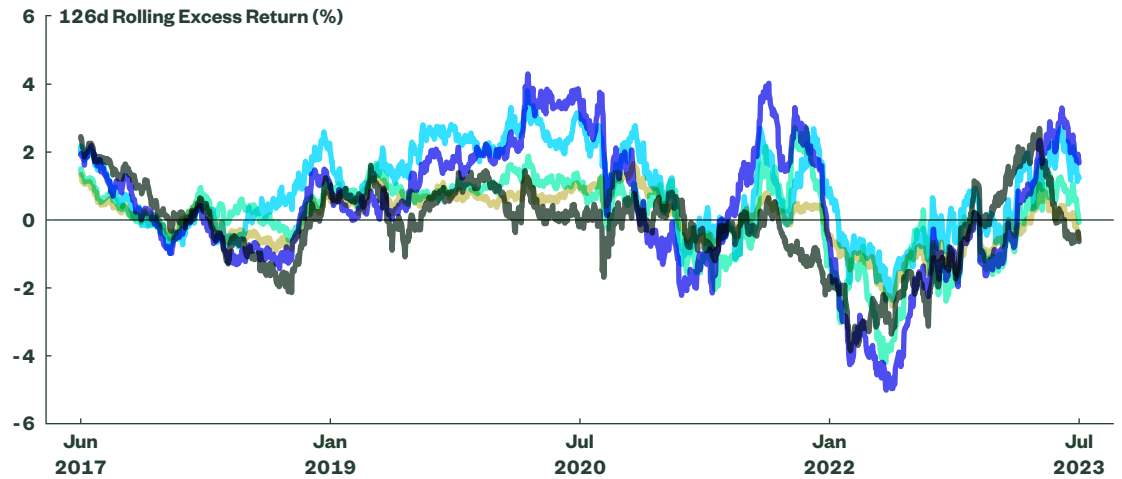
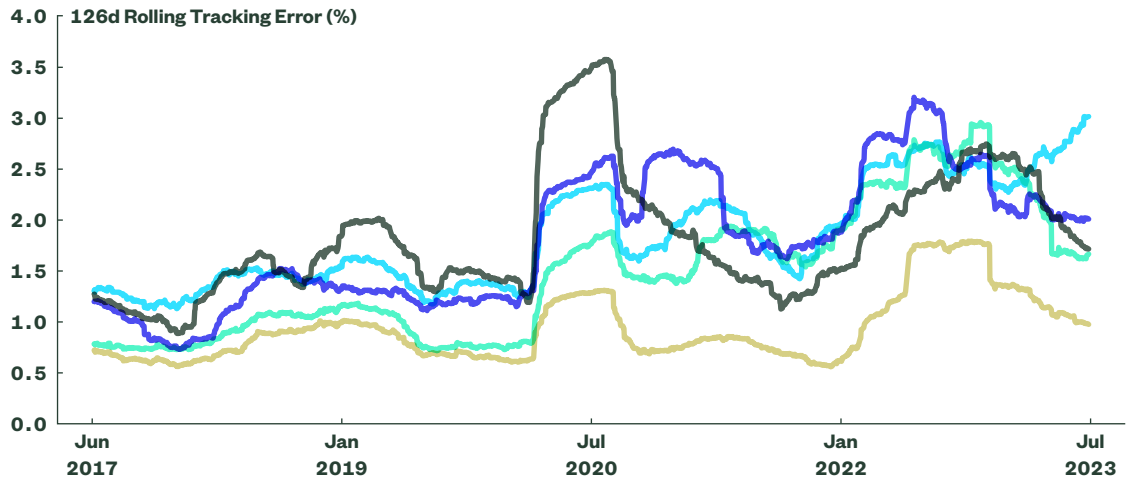
	Solactive PAB	S&P PAB	FTSE PAB	MSCI PAB	MSCI PAB Overlay	Solactive CTB	S&P CTB	FTSE CTB	MSCI Climate Change	MSCI CTB Overlay
Alpha	0	0	0.0000*	0	0	0	0	0	0	0
Beta	0.9580***	0.9931***	0.9755***	0.9938***	0.9893***	0.9640***	1.0068***	0.9788***	1.0072***	0.9962***
Small Size	0.1173***	-0.0701***	-0.0738***	0.0198**		0.0788***	-0.0567***	-0.0590***	-0.0376***	
Value	-0.0526***	-0.1162***	-0.0524***	-0.0897***	-0.0397***	-0.0124***	-0.0886***	-0.0273***	-0.1335***	-0.0167***
Quality	0.0825***		0.0890***		0.0207***	0.0696***		0.0863***	-0.0337***	0.0067**
Momentum	-0.0273***	-0.0222***	-0.0212***	-0.0322***	-0.0194***	-0.0176***		-0.0282***	-0.0325***	-0.0110***
R-squared Adj.	0.9921	0.9931	0.9893	0.9933	0.9971	0.9952	0.9954	0.9907	0.9937	0.9994
N.obs	1702	1702	1702	1702	1702	1702	1702	1702	1702	1702

Source: MSCI &, S&P, FTSE, Solactive & Kenneth French Data Library. Data as of 31 July 2023. Chart for Illustrative Purposes.

Appendix 9:
Tracking Error Varies
Among EU Climate
Benchmarks

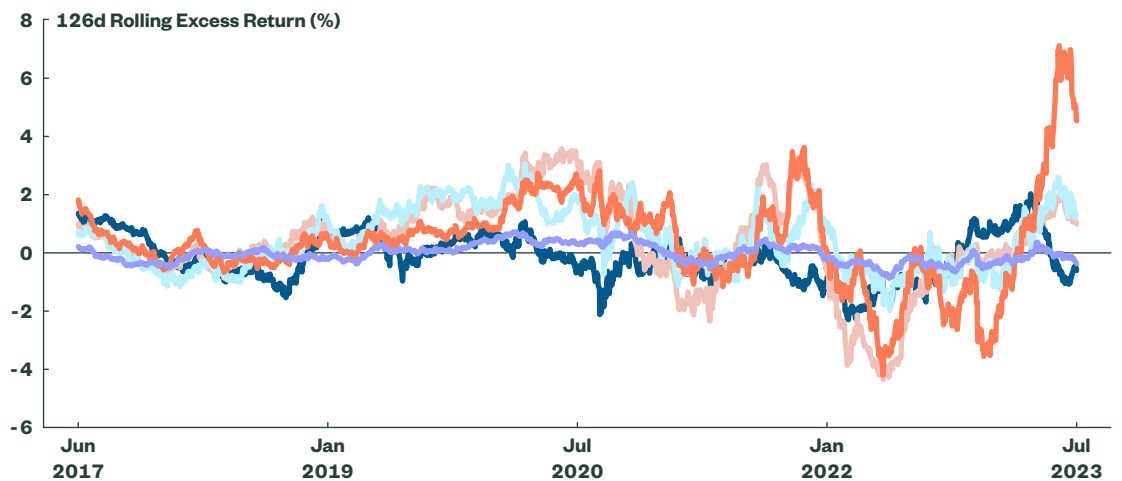
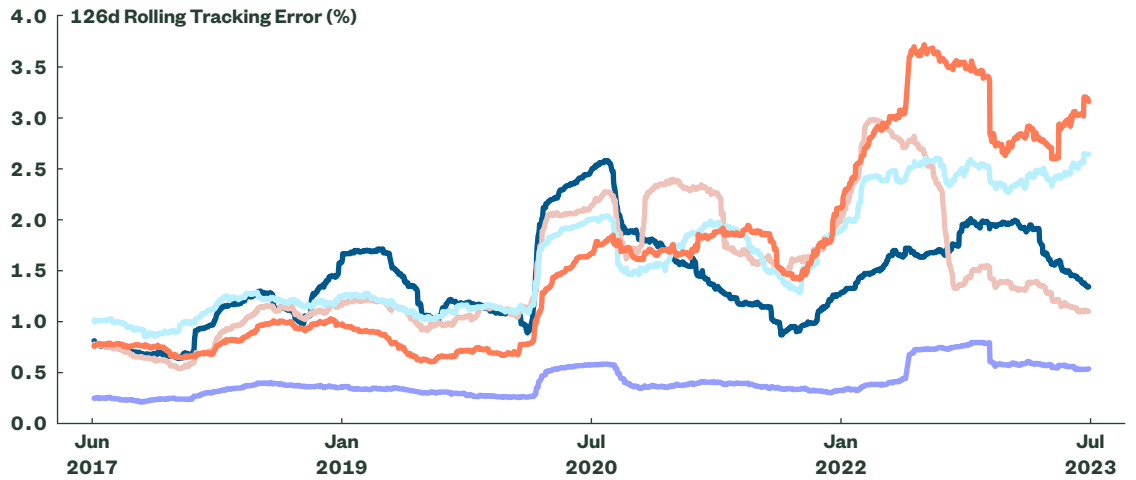
Paris Aligned
Benchmarks

- Solactive PAB
- MSCI PAB
- S&P PAB
- MSCI PAB Overlay
- FTSE PAB



Climate Transition
Benchmarks

- Solactive CTB
- MSCI Climate Change
- S&P CTB
- MSCI CTB Overlay
- FTSE CTB



Source: S&P, MSCI, FTSE, Solactive, State Street Global Advisors, 30 June 2023. Chart for illustrative purposes.

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Endnotes

- 1 We acknowledge that index providers also differ in their implementation of the regulations, which can impact the index. For example, when the base date for decarbonisation and how they interpret the DNSH proportion of the regulations can cause significant differences, especially in indices with fewer features beyond the regulatory minimum standards.
- 2 GFANZ members expressed the need for sound and forward-looking portfolio alignment methods (2022), the IIGCC state forward-looking metrics should be incorporated into the construction process (2023), one of NZAOA ten principals for net zero aligned benchmarks is to ensure that forward-looking indicators are a key input in the decarbonisation process (2022) and key features of the TCFD recommendations are to solicit decision-useful, forward-looking information on financial impacts (2017).
- 3 The SSGA active fundamental approach to the climate transition has a climate scorecard fully integrated into the research framework (State Street Global Advisors, 2023).
- 4 Tracking error minimisation minimises ex-ante tracking error, which is a prediction of future tracking error rather than tracking error its self.
- 5 We use 1-year return, volatility and tracking error figures as many of the indices have either a short period of live history, or there have been significant changes via a consultation.
- 6 This is similar to findings from Scientific Beta on ESG indices (2021).
- 7 Appendix 6 shows the same performance over the past year, with similar conclusions and Appendix 8 shows since 31st December 2016, which is the period for which we have data across each index. Appendix 8 does show a significant alpha for the FTSE PAB, but this is only apparent when including backtested performance rather than live history.
- 8 This is an approximation for multiple reasons. Firstly, as the index takes into account practical portfolio management considerations such as liquidity and turnover. Without these, the tracking error of the index may be lower, at the expense of practical implementation such as transaction costs, when implemented in live portfolios. Secondly, the indices minimise ex-ante tracking error, which is a model of expected future tracking error. As with any model, the future will likely not play out precisely in line with expectation.
- 9 This is measured over the past year using daily data.
- 10 These are the findings of Bender, Mohamed & Sun (2022).
- 11 Returns are daily returns excess over the MSCI World for one year, as of 31st July 2023.
- 12 The cluster analysis uses hierarchical clustering. Hierarchical clustering's use in assessing or building portfolios is evidenced both in SSGA research (Ung, Chawla, & Miklaszewski, Can Machine Learning Improve Portfolio Risk-Adjusted Performance?, 2023; Positioning for Success in US Exposures, 2023) and beyond, including Lopez de Prado, who introduced the concept of Hierarchical Risk Parity (2016) and Hepsen & Vatansever utilised hierarchical clustering within the Turkish residential real estate market (2011).
- 13 Scope 3 being phased-in during a four-year timeframe.
- 14 Societal norms include UNGC Principles, OECD Guidelines for Multinational Enterprises and the 6 Environmental Objectives: 1) climate change mitigation; 2) climate change adaptation; 3) sustainable use and protection of water and marine resources; 4) transition to a circular economy, waste prevention and recycling; 5) pollution prevention and control; 6) protection of healthy ecosystems.

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* Pensions & Investments Research Center, as of December 31, 2022.

† This figure is presented as of December 31, 2023 and includes approximately \$64.44 billion USD of assets with respect to SPDR products for which State Street Global Advisors Funds Distributors, LLC (SSGA FD) acts solely as the marketing agent. SSGA FD and State Street Global Advisors are affiliated.

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