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ACHIEVING NET ZERO: INVESTMENT FRAMEWORKS AND BEST PRACTICES

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ABSTRACT

Leveraging on the latest research and industry best practices, the paper describes four specific frameworks for institutional investors to align equity portfolios with net zero pathways: a forward-looking approach using BNP Paribas Asset Management's 'Net Zero Achieving, Aligned, Aligning' (AAA) screens, the Paris Aligned Benchmark (PAB) rules, fossil fuel exclusions, and clean energy thematic investing. The strengths and weaknesses of each framework are analyzed, along with an evaluation of their potential to support the goals of various institutional investors in guiding their portfolios towards achieving net zero commitments.

KEYWORDS

Net zero, Paris Agreement, climate change, sustainable investing, PAB, decarbonisation, green finance.

JEL Classification: G11, G18, G54.

1. INTRODUCTION

In response to the pressing issue of climate change, institutional investors are actively seeking methods to align their portfolios with targets for net zero financed emissions. There is no unique framework to reach this goal and currently proposed frameworks range from traditional fossil fuel exclusions and carbon footprint reduction to frameworks that prioritise increasing investment exposure to companies whose revenue, or operating expenditure and capital expenditure, are aligned with the environmental transition. Many investors put a strong focus on corporate engagement and public policy advocacy in their approach to achieving net zero portfolios (in addition to, or instead of, other frameworks).

In this paper, we extend our original analysis published in Leote de Carvalho et al. (2024) by exploring four investment frameworks, namely BNP Paribas Asset Management's (BNPP AM) 'Net Zero Achieving, Aligned, Aligning' (NZ:AAA) screens, the Paris Aligned Benchmark (PAB) rules, fossil fuel exclusions and a clean energy thematic investment (index) framework.

The PAB rules and fossil fuel exclusions have been found to be effective at reducing the carbon intensity of investment portfolios by excluding companies that are currently the biggest emitters of greenhouse gases (GHGs). PAB rules also provide a clear pathway to net zero by defining a trajectory for reducing the carbon intensity of the portfolio over time. However, these frameworks are based on backward-looking carbon intensity reductions, relying on historical emissions data which is often not reported but estimated by data vendor models and which is characterised by uncertainty. The frameworks do not formally incorporate a more forward-looking dimension[1], e.g., credible plans of companies to decarbonise, nor do they consider that companies in different sectors have varying starting points and that, therefore, different levels of effort are required to achieve net zero by 2050. Moreover, by disinvesting from the biggest emitters today, or from fossil fuel companies altogether, a PAB-based approach and fossil fuel exclusions will not incentivise investor engagement and stewardship with such companies aimed at accelerating progress toward net zero targets.

On the other hand, the emerging alignment frameworks are based on forward-looking data. They put less focus on decarbonising today and more focus on finding companies that, even if they are high emitters today, are taking climate change seriously, in other words, companies that are committed to net zero by 2050 and that have a strategy to get there. These frameworks are being put forward by the Institutional Investors Group on Climate Change (IIGCC) and have been designed to align with the recommendations of the UN-convened Net-Zero Asset Owner Alliance and of the UN High Level Expert Group (HLEG) on the Net Zero Emissions Commitments of Non-State Entities. Unlike the PAB rules and fossil fuel exclusions, alignment frameworks facilitate engagement with a view to reducing real world emissions by not excluding all high emitters. Here we outline how an alignment framework can be implemented in practice and compare it with the other frameworks.

1 The EU PAB regulation does recommend that the weight of companies that set and publish greenhouse gas emission reduction targets can be increased in PAB benchmark indices provided they publish targets and can demonstrate success in their reduction of emissions. However, the implementation of this recommendation is voluntary and, while it is implemented by some providers of PAB indices, it is not considered here.

The paper is organised as follows: in section 2, we discuss the four different frameworks, including the NZ:AAA screens, the PAB rules, fossil fuel exclusions, and a clean energy thematic index approach. In section 3, we provide a comparative analysis of these frameworks examining the impact of the exclusions of the different frameworks on the breadth of the investment universe and on the market capitalisation available in regions and sectors for investing after exclusions. We investigate the impact on the risk, expected returns, and sustainability of minimum tracking error portfolios relative to their respective market capitalisation weighted benchmarks. Finally, we discuss the strengths and weaknesses of each framework, noting that each has its own merits and limitations. In section 4, we discuss the alignment of the net zero frameworks with the recommendations of various organisations which have as their mission decarbonising the economy and achieving net zero emissions by 2050 and beyond. In particular, we consider the UN HLEG, the IIGCC, the UN-convened Net-Zero Asset Owner Alliance, the Glasgow Financial Alliance for Net Zero (GFANZ) and the Net Zero Asset Managers initiative (NZAM).

2. FRAMEWORKS FOR NET ZERO PATHWAYS

In this section, we present four different frameworks. The first is based on classifying companies in terms of their efforts towards alignment with a 'net zero by 2050' strategy. The second is the EU's PAB framework. The third is simple exclusion of fossil fuels from portfolios and finally we consider a dark green portfolio investing only in clean energy companies. For simplicity's sake, we consider these approaches in the context of equity investments. A subsequent paper could explore the implications for fixed income and private markets investments.

2.1. NZ:AAA: ACHIEVING, ALIGNED, ALIGNING SCREENS

BNPP AM's proprietary NZ:AAA screens are based on a forward-looking framework inspired by the net zero framework of the Paris Aligned Investment Initiative (PAII)[2] proposed by the IIGCC[3] and underpinning BNPP AM's net zero commitment. The framework addresses two major themes: i) activity-based alignment with the environmental transition and ii) carbon footprint reduction targets. Companies are categorised as Achieving, Aligned or Aligning if they report sufficient revenues associated with climate mitigation linked to the UN Sustainable Development Goals (SDGs)[4] or aligned with the EU Taxonomy[5], or if they have published carbon reduction targets assessed as being consistent with efforts to limit global warming to 1.5°C or 2°C. Data sources include the Science Based Targets initiative (SBTi)[6] or the SBTi tool using data from the Carbon Disclosure Project (CDP)[7], the Transition Pathway initiative

2 https://www.iigcc.org/our-work/paris-aligned-investment-initiative/
3 https://www.iigcc.org/
4 https://sdgs.un.org/goals
5 https://ec.europa.eu/sustainable-finance-taxonomy/
6 https://sciencebasedtargets.org/
7 https://www.cdp.net/

(TPi)[8] and the Climate Action 100+ Net Zero Company Benchmark (CA 100+)[9]. In particular, companies are classified as:

Achieving net zero, i.e., companies already achieving the emissions intensity required for net zero by 2050 and with an investment plan or business model that ensures continued achievement of that goal over time, or with revenues contributing significantly towards climate change mitigation, which is assessed by looking either for:

- Companies committed to net zero and whose current carbon performance is at (or close) to what is needed for its sector by 2050 to reach net zero global emissions OR
- Companies with at least 50% of their turnover aligned with EU Taxonomy Climate Change Mitigation OR
- Companies with at least 50% of their turnover aligned with climate mitigation-linked SDGs10 and with no more than 20% of their turnover misaligned with any SDGs.

Aligned to a net zero pathway, i.e., companies that have a 2050 net zero ambition with short and medium-term targets for emissions reductions, with current emissions intensity performance considered acceptable, with appropriate disclosure of Scope 1, 2 and material Scope 3 emissions11, with a quantified decarbonisation strategy and with capital spending plans consistent with achieving net zero emissions by 2050, or with revenues contributing towards climate change mitigation, which is assessed by looking either for:

- Companies committed to net zero emissions by 2050 AND that have a carbon reduction target assessed as alignment with a scenario of a global temperature increase at or below 1.5°C[12] OR
- Companies with at least 20% of their turnover aligned with EU Taxonomy Climate Change Mitigation OR
- Companies with at least 20% of their turnover aligned with climate mitigation-linked SDGs[13] and with no more than 20% of their turnover misaligned with any SDGs.

Aligning towards net zero pathway, i.e., companies that have set short and medium-term targets for emissions reduction, with appropriate disclosure of Scope 1, 2 and material Scope

8 https://www.transitionpathwayinitiative.org/
9 https://www.climateaction100.org/net-zero-company-benchmark/
10 UN Sustainable Development Goals (SDG) target numbers: 7.2, 7.3, 7.a, 7.b, 9.4
11 The scopes of company carbon emissions are defined by the Greenhouse Gas protocol (https://ghgprotocol.org/):
- Scope 1 is the sum of direct GHG emissions from sources that are owned or controlled by the company, which include stationary combustion, e.g., burning oil, gas, coal and others in boilers or furnaces; mobile combustion, e.g., from fuel-burning cars, vans or trucks owned or controlled by the firm; process emissions, e.g., from chemical production in owned or controlled process equipment such as the emission of CO2 during cement manufacturing; and fugitive emissions from leaks of GHG gases, e.g., from refrigeration or air conditioning units.
- Scope 2 is the sum of indirect GHG emissions associated with the generation of purchased electricity, steam, heat or cooling consumed by the company.
- Scope 3 is the sum of all other indirect emissions that occur in the value chain of the company, including upstream emissions from purchased goods and services, capital goods, fuel and energy-related activities, transportation and distribution, waste generated in operations, business travel or employee commuting; and downstream emissions from leased assets, processing of sold products, use of sold products, end of life treatment of sold products, franchises or investments.

12 Companies with 1.5°C temperature alignment is determined based on a variety of different inputs:
- SBTi or SBTi tool using CDP data produces at or below 1.5°C output for any assessed time frame,
- TPi Management Quality Level 4 with short- and medium- or long-term carbon performance at or below 1.5°C,
- Indicator 1 to 6 in the CA100+ benchmark (Structure and Methodologies | Climate Action 100+)

13 SDG target numbers: 7.2, 7.3, 7.a, 7.b, 9.4.

3 emissions, with a plan relating to how they will achieve these targets, which is assessed by looking either for:

- Companies that have a carbon reduction target assessed as alignment with a scenario of a global temperature increase of below 2°C[14] and not otherwise considered Achieving or Aligned.

With this framework, we screen out all companies with non-existent or insufficiently robust climate commitments.

According to the PAII, this kind of classification enables investors to set and measure the performance of the portfolio against the net zero targets and should also inform their strategy for alignment actions; companies not showing adequate progress towards meeting NZ:AAA criteria should be the priority for engagement or reweighting in portfolio construction.

When it comes to divestment or exclusions, the PAII suggests that consideration should be given to the companies that do not meet any of the criteria indicating that they have the potential to transition within a specified timeframe that is consistent with remaining on a global net zero pathway. Companies that do not continue to improve performance against the criteria over the longer term should also be investigated.

2.2. PAB: PARIS ALIGNED BENCHMARKS

In May 2018, the European Commission proposed an amendment to its Benchmark Regulation (EU) 2016/1011, which establishes the framework for benchmarks referenced in financial instruments, financial contracts, or investment funds in the EU. The resulting regulation (EU) 2020/1818[15] introduces standards for the methodology of low-carbon benchmarks in the EU, in line with its Action Plan *Financing Sustainable Growth*. The act outlines minimum requirements for the design of PABs and EU Climate Transition Benchmarks (CTBs), which are based on the commitments set forth in the Paris Agreement and therefore rely on the use of the 1.5 °C scenario, with no or limited overshoot, referred to in the Special Report on Global Warming of 1.5 °C from the Intergovernmental Panel on Climate Change (IPCC)[16].

The amended Benchmark Regulation is consistent with the Commission's objective of attaining net zero GHG emissions by 2050. Both EU PABs and CTBs share similar objectives, with the only difference being their level of ambition.

This paper will solely focus on PABs and in our PAB portfolio we only apply the minimum requirements as outlined in the regulation and described in detail in the appendix. Of these, we did not include Scope 3 emissions, not even for the energy and mining sectors as required from inception. Our choice is motivated by the poor quality of Scope 3 data (Nguyen et al. (2022)). The minimum standards of the PAB regulation can be summarised as:

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14 Companies with 1.5°C to 2.0°C temperature alignment is determined based on a variety of different inputs:
- SBTi or SBTi tool using CDP data produces at or below 1.5°C output,
- TPi Management Quality at least Level 3 with a short-, medium- or long-term carbon performance between 1.5°C and 2°C.
- Indicator 1 to 3 in the CA 100+ Net Zero benchmark (Structure and Methodologies | Climate Action 100+).
- Committed to net zero emissions by 2050 and below 2°C using BNPP AM's enhanced Implied Temperature Rise.

15 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R1818

16 IPCC, 2018: Global Warming of 1.5 °C. An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

- Baseline reduction of GHG intensity, so that it is at least 50% lower than the GHG intensity of the investable universe
- Setting a decarbonisation trajectory to reduce the average GHG intensity by at least 7% a year
- S etting an allocation to high-impact[17] sectors that is at least equivalent to the aggregated exposure of the underlying investable universe to those sectors
- Excluding companies based on their activity in controversial weapons, tobacco, hard coal and lignite, oil fuels and gaseous fuels.

Following the EU regulation, the GHG intensity of each company is calculated by dividing the sum or its GHG emissions by its enterprise value including cash (EVIC). The regulation determines that, when calculating the decarbonisation trajectory, the GHG intensity of each company is divided by an inflation adjustment factor defined as the ratio of the average EVIC of the benchmark at the end of the calendar year to the average EVIC of the benchmark at the end of previous calendar year. These choices imposed by regulation have two consequences which are not always fully appreciated.

The first is that the inflation adjustment factor forces the absolute emissions of the PAB to fall over time. Without this adjustment, it would have been possible for the absolute emissions of the PAB portfolio to increase for as long as the EVIC of its constituent companies increased faster than their emissions, for example, from sufficiently large increases in share prices from one year to the next. This adjustment is thus crucial for PABs to reduce their absolute emissions over time.

The second consequence is that the GHG intensity of a company may fall even if its carbon emissions increase for as long as its EVIC increases faster than the GHG emissions. Similarly, for a company successfully reducing its carbon emissions, it is still possible that its carbon intensity increases, which will happen for as long as its EVIC decreases fast enough, for example, as a result of the company's share price falling.

2.3. FOSSIL FUEL EXCLUSIONS: COAL, UNCONVENTIONAL OIL AND GAS AND OTHER FOSSIL FUELS

Investors use fossil fuel divestment as a strategy to manage stranded asset[18] risks associated with the energy transition and address climate change by putting pressure on fossil fuel companies to shift their focus. Divestment is expected to achieve these objectives by avoiding exposure to potential stranded assets and by increasing the cost of capital for fossil fuel companies or stigmatising them, which can result in a loss of their social license to operate.

Rohleder et al. (2022) analysed a sample of actively managed mutual funds and found that companies with higher carbon intensity experienced greater selling pressure, leading to a

17 Section A: Agriculture, Forestry and Fishing; Section B: Mining and Quarrying; Section C: Manufacturing, Section D: Electricity, Gas, Steam and Air Conditioning Supply; Section E: Water Supply, Sewerage, Waste Management and Remediation Activities; Section F: Construction; Section G: Wholesale and Retail Trade; Section H: Transportation and Storage; Section L: Real Estate Activities

18 https://carbontracker.org/terms/stranded-assets/

decline in their stock prices. They also found that those same companies subsequently reduced their carbon emission intensity after investors divested. More recently, empirical research by Gehricke et al. (2023) measured coordination in divestment by investigating the impact of a higher number of ESG exchange-traded funds (ETFs) divesting from a firm in the same quarter and found that divestment not only has a prolonged negative impact on a company's share price, but also increases the cost of capital. These findings suggest that divestment, in particular coordinated divestment, can be an important tool in the sustainability transition, even though it increases sustainable performance only indirectly. In turn, Dordi and Weber (2019) examined how stakeholder awareness of public divestments of the top 200 global oil, gas, and coal companies by proven reserves could affect future cashflows and increase reputational risks. The study found that the effects of divestment announcements were more pronounced over longer event windows, suggesting a shift in investor perception. The study also found that divestment announcements related to campaigns, pledges, and endorsements all have a significant effect over the short-term event window. Additionally, the study noted that divestment may directly depress share prices or stigmatise the industry's reputation, resulting in lower share values.

The idea of fossil fuel divestment started on US college campuses in 2011, with students campaigning for their administrations to shift endowment investments away from the fossil fuel industry into clean energy and communities most affected by climate change (Gibson and Leslie (2020)). As of October 2021, 1 485 institutions worldwide representing USD 39.2 trillion in assets had committed to divesting from fossil fuels[19].

In this paper, we consider first the complete exclusion of all fossil fuel companies. Additionally, we analyse coal exclusions defined as the exclusion of

i) the set of companies from the NACE[20] level 2 industry mining of coal and lignite which:

- are developing or planning to develop thermal coal extraction capacities (new mines or expansion of existing ones), OR
- derive more than 10% of their revenues from the mining of thermal coal, OR
- produce more than 10 million tonnes of thermal coal per year, OR
- do not have a strategy to phase out thermal coal activities by 2030 in EU and OECD countries and by 2040 for the rest of the world.

ii) the set of electricity producers which:

- are adding operational coal-fired power generation capacity to their power portfolio, OR
- have a carbon intensity above 400 gCO2e/kWh today[21], OR
- still have coal capacity in their generation mix by 2030 in EU and OECD countries and by 2040 for the rest of the world.

19 https://old.stand.earth/sites/stand/files/divestinvestreport2021.pdf

20 Nomenclature of Economic Activities is the European statistical classification of economic activities

21 This should be tightened further in the future following the Paris-compliant trajectory for the sector as determined by the International Energy Agency's (IEA) Sustainable Development Scenario (SDS), which means that the carbon intensity of electricity producers will fall to 346 gCO2e/kWh by 2025.

Finally, in our analysis, we considered the exclusion of unconventional oil and gas companies defined as:

- pure upstream oil and gas companies, on the basis of their reserves, excluding those with more than 10% of unconventional reserves, OR
- diversified energy companies with an Unconventional Ratio[22] above 10%, OR
- energy companies that generate more than 10% of their revenues from unconventional oil and gas, OR
- trading companies for which unconventional oil and gas resources represent more than 30% of their business, OR
- companies that own or operate pipelines or export terminals of liquified natural gas (LNG) supplied with more than 30% of their volume in unconventional oil and gas.

2.4. DARK GREEN: CLEAN ENERGY THEMATIC INVESTING

Green investing is a rather broad term[23] that has been in use for long to refer to a variety of investment frameworks related to climate change, resource efficiency, and other environmental issues. There are qualitative and quantitative definitions, trying to measure different grades of *greenness*. In particular, *dark green* refers to a portfolio of investments that is more focused on environmental issues and has a higher degree of *greenness* than a *light green* portfolio.

As an example of a dark green framework, we chose to rely on stocks in the WilderHill Global Clean Energy[24] index which tracks the performance of US companies that stand to benefit substantially from a transition to clean energy, and the WilderHill New Energy Global Innovation index which tracks the performance of companies worldwide, mainly outside the US, advancing green energy and efficiency. ETFs tracking the latter index can apply to be classified as Article 9 under the European Union SFDR regulation[25] because its investment strategy was specifically designed to comply with the investment constraints imposed by this regulation.

These two indices explicitly avoid fossil fuel and nuclear power companies. Details about the thresholds used to select stocks for these indices are provided by Solactive[26]. For this paper, in our analysis, we keep only the stocks from these two indices that are also constituents of the MSCI ACWI, MSCI World, MSCI Europe and/or S&P 500 indices to facilitate comparability.

22 The Unconventional Ratio is defined as the share of total revenues from a company's upstream activities multiplied by the share of non-conventional reserves.
23 https://www.oecd.org/environment/WP_24_Defining_and_Measuring_Green_Investments.pdf
24 https://www.wildershares.com/
25 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019R2088 for the EU Sustainable Finance Disclosure Regulation
26 https://www.solactive.com/market-consultation-wilderhill-new-energy-global-innovation-index-february-2022/

3. COMPARATIVE ANALYSIS OF THE FRAMEWORKS

In this section, we compare the various frameworks introduced above. Firstly, for each of the four frameworks, we investigate how many companies are excluded in each region and sector and how much market capitalisation is excluded from the full investment universe. Secondly, we consider minimum tracking error portfolios to investigate the impact on the expected risk, returns and sustainability of an investment strategy that aims at replicating the performance of the underlying market cap index while implementing the constraints of each framework. Finally, we summarise our views on the strengths and weaknesses of each framework.

3.1. IMPACT ON THE BREADTH OF THE INVESTMENT UNIVERSE

Here we compare the impact that the exclusions embedded in the four frameworks have on the breadth of the investment universe.

In exhibit 1, we show the number and the market cap of the stocks that pass each filter from each framework at the end of May 2023. Here, A is used for companies classified as Achieving, AA for companies classified as Aligned or Achieving, and AAA for companies classified as Aligning, Aligned or Achieving.

The first observation is that there are not yet many companies achieving net zero when using the proposed NZ:AAA framework. In fact, all companies currently qualifying as achieving do so through their revenue stream rather than the alignment with net zero of their emissions stream. At global level, only 5.2% of companies making up only 3.5% of the total market capitalisation of stocks in the MSCI ACWI index meet the required criteria. We can also see that more companies in Europe are achieving net zero than those in the US.

Exhibit 1: Number of stocks and market cap from each region screened using different net zero filters

Investment universe	Description	Index	Achieving Aligned Aligning				Paris Aligned		Fossil Fuel Exclusions				Dark Green	
			A	AA	AAA	Not AAA	PAB	Not PAB	Not Fossil Fuels	Fossil Fuels	Coal + Unconv. Oil & Gas	Coal	Clean Energy	Not Clean Energy
MSCI ACWI	Number of stocks	2883	149	666	1065	1818	2473	410	2640	243	27	20	34	2849
	% of stocks	100%	5.2%	23.1%	36.9%	63.1%	85.8%	14.2%	91.6%	8.4%	0.9%	0.7%	1.2%	98.8%
	% of market cap	100%	3.5%	41.5%	61.1%	38.9%	89.4%	10.6%	90.6%	9.4%	1.3%	0.1%	1.4%	98.6%
MSCI World	Number of stocks	1506	74	499	798	708	1338	168	1378	128	25	2	25	1481
	% of stocks	100%	4.9%	33.1%	53.0%	47.0%	88.8%	11.2%	91.5%	8.5%	1.7%	0.1%	1.7%	98.3%
	% of market cap	100%	3.6%	44.4%	64.3%	35.7%	89.6%	10.4%	90.6%	9.4%	1.4%	0.0%	1.5%	98.5%
MSCI Europe	Number of stocks	423	25	223	302	121	394	29	395	28	0	0	12	411
	% of stocks	100%	5.9%	52.7%	71.4%	28.6%	93.1%	6.9%	93.4%	6.6%	0.0%	0.0%	2.8%	97.2%
	% of market cap	100%	5.0%	60.8%	78.7%	21.3%	89.6%	10.4%	90.0%	10.0%	0.0%	0.0%	1.2%	98.8%
S&P 500	Number of stocks	503	19	142	252	251	440	63	458	45	12	0	6	497
	% of stocks	100%	3.8%	28.2%	50.1%	49.9%	87.5%	12.5%	91.1%	8.9%	2.4%	0.0%	1.2%	98.8%
	% of market cap	100%	3.0%	44.6%	63.5%	36.5%	90.0%	10.0%	91.4%	8.6%	1.2%	0.0%	1.8%	98.2%

Data for the Achieving Aligned Aligning and for Paris Aligned were sourced from Leote de Carvalho et al. (2024).

If we consider AAA companies, the investable universe grows to 37% in terms of the number of stocks. However, these represent 61.1% of the market cap of the MSCI ACWI index universe. In the developed world, based on the MSCI World index, the percentage of companies that pass the AAA criteria is higher at 53%, representing 64.3% of the market cap. 71.6% of companies representing 78.7% of the market cap in the MSCI Europe index pass the AAA criteria. For the US, only 49.8% of the companies in the S&P 500 index pass the AAA criteria. Nevertheless, they represent 63.5% of the market cap of the index.

The screens that are imposed by the PAB EU regulation let through a higher number of companies with 85.5% of companies in the MSCI ACWI index representing 89.4% of its market cap passing the filters. However, we note that this does not mean that they can all have a significant weight in PAB indices because of the additional constraints beyond exclusions, in particular the constraints on the portfolio carbon intensity. We shall consider the impact of the other constraints later.

A framework based solely on excluding fossil fuels will let through even more stocks since 91.6% of the stocks in the MSCI ACWI representing 90.6% of its market cap are not considered fossil fuel companies. Coal and unconventional oil and gas companies represent less than 1% of the number of companies in this index. We did not find any of such companies in the MSCI Europe and even in the S&P 500, no coal companies were found, only 12 unconventional oil and gas companies making up 2.4% of the number of stocks and 1.2% of the index market cap.

Finally, a dark green framework which is based on stocks in the WilderHill Global Clean Energy and the WilderHill New Energy Global Innovation indices is the most restrictive with only 1.2% of the companies in the MSCI ACWI and the S&P 500 index qualifying for investment. Even for MSCI Europe index companies, only 2.8% of the companies qualify. This framework is even more restrictive than the filter based on achieving companies from the proposed NZ:AAA framework.

In exhibit 2, we investigate the impact of the filters on the number of screened stocks in each sector as at the end of May 2023. As shown, there are currently no companies from the consumer staples, energy, financials and healthcare sectors classified as achieving net zero. This reflects the fact that at present there are still no companies in these universes that comply with the achieving criteria for emissions. All companies classified as achieving do so through the alignment of their revenue stream with the EU Taxonomy Climate Change Mitigation or climate-mitigation-linked SDGs. It is the case that such companies are found in sectors such as industrials, information technology, real estate and utilities. However, the picture changes significantly when we include aligned companies. Only the energy sector does not have any company that are either achieving or aligned. If we include companies that are aligning, we find AAA companies from every single sector.

For the PAB framework, no company from the energy sector passes its exclusions criteria. We can also see that PAB exclusions screen out not only stocks from the energy sector, but also stocks from all other sectors, at least for the global indices.

Exhibit 2: Number of stocks from each sector screened using different net zero filters

Sector GICS 1	Investment universe	Index	Achieving Aligned Aligning				Paris Aligned		Fossil Fuel Exclusions				Dark Green	
			A	AA	AAA	Not AAA	PAB	Not PAB	Not Fossil Fuels	Fossil Fuels	Coal + Unconv. Oil & Gas	Coal	Clean Energy	Not Clean Energy
Communication Services	MSCI ACWI	158	1	48	64	94	146	12	156	2				158
	MSCI World	89		38	48	41	87	2	87	2				89
	MSCI Europe	26		22	25	1	26		25	1				26
	S&P 500	24		7	9	15	24		24					24
Consumer Discretionary	MSCI ACWI	292	8	79	117	175	271	21	287	5			6	286
	MSCI World	157	3	64	90	67	149	8	155	2			3	154
	MSCI Europe	52		34	41	11	51	1	52					52
	S&P 500	53	1	17	24	29	53	0	52	1			1	52
Consumer Staples	MSCI ACWI	229		66	102	127	201	28	229					229
	MSCI World	110		52	78	32	103	7	110					110
	MSCI Europe	39		26	32	7	36	3	39					39
	S&P 500	37		13	26	11	35	2	37					37
Energy	MSCI ACWI	114			25	89		114	9	105	42	16		114
	MSCI World	57			23	34		57	4	53	24			57
	MSCI Europe	11			10	1		11	1	10				11
	S&P 500	23			9	14		23	2	21	12			23
Financials	MSCI ACWI	477		50	126	351	454	23	468	9	1	1		477
	MSCI World	239		36	96	143	230	9	232	7	1	1		239
	MSCI Europe	81		25	43	38	81		80	1				81
	S&P 500	72		8	28	44	71	1	70	2				72
Healthcare	MSCI ACWI	255		48	66	189	245	10	255					255
	MSCI World	142		46	61	81	142		142					142
	MSCI Europe	40		16	20	20	40		40					40
	S&P 500	65		22	28	37	65		65					65
Industrials	MSCI ACWI	453	44	121	188	265	412	41	405	48			8	445
	MSCI World	266	22	87	147	119	249	17	244	22			7	259
	MSCI Europe	81	9	42	58	23	80	1	77	4			4	77
	S&P 500	76	6	17	32	44	70	6	70	6			1	75
Information Technology	MSCI ACWI	324	30	104	136	188	305	19	323	1			8	316
	MSCI World	157	9	66	81	76	151	6	156	1			4	153
	MSCI Europe	16	2	12	13	3	16		15	1				16
	S&P 500	64	2	25	33	31	64		64				3	61
Materials	MSCI ACWI	304	6	44	96	208	245	59	272	32	4	3	3	301
	MSCI World	115	1	29	59	56	101	14	103	12	2	1	2	113
	MSCI Europe	38	0	17	27	11	34	4	35	3			1	37
	S&P 500	29	1	8	18	11	25	4	26	3			1	28
Real Estate	MSCI ACWI	136	21	41	57	79	131	5	135	1				136
	MSCI World	96	18	37	53	43	95	1	95	1				96
	MSCI Europe	14	4	9	10	4	14		14					14
	S&P 500	30	4	9	20	10	30		29	1				30
Utilities	MSCI ACWI	141	39	65	88	53	63	78	101	40			9	132
	MSCI World	78	21	44	62	16	31	47	50	28			9	69
	MSCI Europe	25	10	20	23	2	16	9	17	8			7	18
	S&P 500	30	5	16	25	5	3	27	19	11				30

As expected, exclusions based on fossil fuel exclusions have an even smaller impact than PAB or NZ:AAA exclusions, while a dark green framework investing only in clean energy stocks will be the most restrictive excluding all stocks from seven sectors and letting through only a small selection of stocks from the other sectors. Indeed, this framework is the most constraining with only a few stocks going through mainly from the utilities, information technology, industrial and consumer discretionary sectors. The number of stocks remaining is even smaller than the achieving stocks. The latter screen also lets through stocks from the real estate sector. This is not the case for the clean energy screen.

In exhibit 3, we show the sum of the market cap weight of the stocks in each sector that pass the different screens as at the end of May 2023. The figures are not rebased and represent just the sum of the weight in the market cap weighted index of all the stocks from a given sector that pass each respective screen.

We can see that most of the market cap of utilities stocks are classified as AAA. The total market cap weight of utility companies is one of the smallest, varying between 2.7% for stocks in the S&P 500 index and 4.2% for stocks in the MSCI Europe index. Only the real estate sector has a smaller market cap weight than utilities.

For the largest sector in terms of weight in the MSCI ACWI, information technology with 21.9%, the market cap weight of AAA companies adds up to 17.5%. Larger sectors such as consumer discretionary, consumer staples, financials and industrials tend to have half or more of their market cap weight made up of AAA companies. Materials, real estate and energy, which are relatively small sectors, have only about half of their market cap weight represented by AAA companies.

Unlike the NZ:AAA framework, the PAB framework lets through most of the market cap of all sectors except for energy and utilities, which are strongly constrained by exclusions. The same happens when looking at fossil fuel company exclusions, where again the energy and utility sectors are most impacted by exclusions in terms of market cap, but slightly less so when compared to the PAB exclusions.

Finally, the dark green framework has most of the market cap from each sector excluded and, as seen before, many sectors are actually excluded completely. Moreover, for the stocks classified as clean energy in the utilities, information technology, industrial and consumer discretionary sectors, the sum of the market cap weight in their respective sectors is small. Even compared to achieving stocks, the sum of the market cap weight of clean energy stocks is significantly smaller.

Exhibit 3: Market cap of stocks from each sector screened using different net zero filters

Sector GICS 1	Investment universe	Index	Achieving Aligned Aligning				Paris Aligned		Fossil Fuel Exclusions				Dark Green	
			A	AA	AAA	Not AAA	PAB	Not PAB	Not Fossil Fuels	Fossil Fuels	Coal + Unconv. Oil & Gas	Coal	Clean Energy	Not Clean Energy
Communication Services	MSCI ACWI	7.5%	0.0%	2.5%	2.6%	4.9%	7.4%	0.1%	7.5%	0.1%				7.5%
	MSCI World	7.3%		2.2%	2.3%	5.0%	7.3%	0.0%	7.2%	0.1%				7.3%
	MSCI Europe	3.3%		3.2%	3.3%	0.0%	3.3%		3.2%	0.1%				3.3%
	S&P 500	8.7%		1.9%	2.0%	6.7%	8.7%		8.7%					8.7%
Consumer Discretionary	MSCI ACWI	10.7%	0.9%	5.9%	7.3%	3.4%	10.5%	0.2%	10.6%	0.1%			0.9%	9.8%
	MSCI World	10.5%	1.0%	6.4%	7.8%	2.8%	10.4%	0.1%	10.4%	0.1%			1.0%	9.5%
	MSCI Europe	11.5%		8.2%	9.2%	2.2%	11.5%	0.0%	11.5%					11.5%
	S&P 500	10.1%	1.5%	6.5%	7.5%	2.6%	10.1%	0.0%	10.0%	0.1%			1.5%	8.6%
Consumer Staples	MSCI ACWI	7.5%		3.9%	5.9%	1.7%	6.8%	0.7%	7.5%					7.5%
	MSCI World	7.7%		4.1%	6.3%	1.4%	7.0%	0.7%	7.7%					7.7%
	MSCI Europe	12.8%		11.0%	12.0%	0.8%	11.7%	1.1%	12.8%					12.8%
	S&P 500	6.9%		2.7%	5.5%	1.5%	6.3%	0.6%	6.9%					6.9%
Energy	MSCI ACWI	4.8%			1.8%	2.9%		4.8%	0.2%	3.2%	1.3%	0.1%		4.8%
	MSCI World	4.7%			2.0%	2.7%		4.7%	0.2%	3.2%	1.4%			4.7%
	MSCI Europe	5.8%			5.8%	0.1%		5.8%	0.1%	5.8%				5.8%
	S&P 500	4.3%			1.2%	3.1%		4.3%	0.3%	2.8%	1.2%			4.3%
Financials	MSCI ACWI	15.5%		2.6%	7.4%	8.1%	14.6%	0.9%	14.6%	0.9%	0.0%	0.0%		15.5%
	MSCI World	14.7%		2.7%	7.9%	6.8%	13.7%	1.0%	13.7%	1.0%	0.0%	0.0%		14.7%
	MSCI Europe	17.0%		3.8%	8.9%	8.1%	17.0%		16.8%	0.2%				17.0%
	S&P 500	12.6%		3.0%	6.8%	5.8%	10.9%	1.6%	10.9%	1.7%				12.6%
Healthcare	MSCI ACWI	12.1%		5.5%	6.8%	5.3%	12.1%	0.0%	12.1%					12.1%
	MSCI World	13.1%		6.2%	7.5%	5.6%	13.1%		13.1%					13.1%
	MSCI Europe	16.1%		11.0%	11.3%	4.8%	16.1%		16.1%					16.1%
	S&P 500	13.6%		6.0%	7.6%	6.1%	13.6%		13.6%					13.6%
Industrials	MSCI ACWI	10.3%	1.0%	3.7%	6.0%	4.3%	9.3%	1.0%	9.0%	1.3%			0.2%	10.1%
	MSCI World	10.8%	1.1%	4.0%	6.5%	4.3%	9.8%	1.0%	9.5%	1.3%			0.2%	10.6%
	MSCI Europe	14.9%	2.5%	9.9%	12.3%	2.5%	14.7%	0.1%	14.5%	0.4%			0.6%	14.2%
	S&P 500	8.3%	0.5%	1.9%	3.8%	4.5%	7.5%	0.8%	7.3%	1.0%			0.1%	8.3%
Information Technology	MSCI ACWI	21.9%	0.4%	13.9%	17.5%	4.4%	21.7%	0.2%	21.9%	0.0%			0.2%	21.7%
	MSCI World	22.0%	0.4%	15.1%	18.1%	3.9%	21.8%	0.2%	21.9%	0.1%			0.1%	21.9%
	MSCI Europe	6.9%	0.3%	6.1%	6.6%	0.3%	6.9%		6.6%	0.3%				6.9%
	S&P 500	28.0%	0.1%	19.8%	24.1%	3.9%	28.0%		28.0%				0.2%	27.8%
Materials	MSCI ACWI	4.6%	0.1%	1.1%	2.3%	2.2%	3.8%	0.7%	3.7%	0.8%	0.1%	0.0%	0.1%	4.5%
	MSCI World	4.1%	0.1%	1.0%	2.2%	1.9%	3.6%	0.6%	3.3%	0.7%	0.1%	0.0%	0.1%	4.0%
	MSCI Europe	6.8%		3.2%	4.5%	2.3%	5.6%	1.2%	5.7%	1.1%			0.1%	6.7%
	S&P 500	2.4%	0.1%	0.5%	1.3%	1.2%	2.1%	0.3%	2.2%	0.3%			0.1%	2.4%
Real Estate	MSCI ACWI	2.3%	0.4%	0.7%	1.3%	1.0%	2.3%	0.0%	2.3%	0.0%				2.3%
	MSCI World	2.4%	0.4%	0.7%	1.4%	0.9%	2.4%	0.0%	2.3%	0.0%				2.4%
	MSCI Europe	0.7%	0.3%	0.5%	0.6%	0.1%	0.7%		0.7%					0.7%
	S&P 500	2.4%	0.3%	0.6%	1.6%	0.8%	2.4%		2.3%	0.1%				2.4%
Utilities	MSCI ACWI	2.8%	0.7%	1.8%	2.3%	0.6%	0.8%	2.0%	1.4%	1.4%			0.1%	2.7%
	MSCI World	2.8%	0.7%	1.9%	2.4%	0.4%	0.7%	2.1%	1.3%	1.5%			0.1%	2.7%
	MSCI Europe	4.2%	1.9%	4.0%	4.2%	0.1%	2.1%	2.1%	2.0%	2.2%			0.5%	3.8%
	S&P 500	2.7%	0.4%	1.6%	2.2%	0.4%	0.3%	2.4%	1.2%	1.5%				2.7%

3.2. IMPACT ON RISK AND RETURNS

In this section, we look at the impact of the different filters on the risk and sustainability of portfolios designed to mimic as much as possible the fully invested market cap-weighted parent indices. For this purpose, we constructed portfolios which invest only in the screened stocks and allocate a weight to each stock chosen so as to minimise the tracking error against the parent market cap index, similar to what was proposed by Andersson, Bolton, and Samama (2016). The minimum tracking error framework is the most adapted strategy for investors that wish to implement a net zero portfolio strategy with the smallest possible expected impact on returns relative to the respective market cap parent index. For PAB portfolios, we include all other required constraints described in section 3 with details in the appendix.

Exhibit 4: Risk of minimum tracking error portfolios

Investment universe	Description	Index	Achieving Aligned Aligning			Paris Aligned	Fossil Fuel Exclusions	Dark Green
			A	AA	AAA	PAB	Not Fossil Fuels	Clean Energy
MSCI ACWI	Number of stocks	2883	82	444	856	1863	1964	33
	Tracking Error		4.3%	1.3%	0.8%	0.4%	0.3%	7.7%
	Volatility	17.6%	17.9%	17.6%	17.6%	17.6%	17.6%	20.2%
	Beta	1.00	0.99	1.00	1.00	1.00	1.00	1.06
MSCI World	Number of stocks	1506	51	391	648	1100	1370	25
	Tracking Error		4.7%	1.4%	0.8%	0.5%	0.4%	8.0%
	Volatility	17.9%	18.3%	17.9%	17.9%	17.9%	17.9%	20.5%
	Beta	1.00	0.99	0.99	1.00	1.00	1.00	1.05
MSCI Europe	Number of stocks	423	25	198	298	357	378	12
	Tracking Error		6.7%	1.3%	0.7%	0.8%	0.7%	9.0%
	Volatility	19.6%	20.9%	19.6%	19.6%	19.6%	19.6%	21.8%
	Beta	1.00	1.01	1.00	1.00	1.00	1.00	1.02
S&P 500	Number of stocks	503	19	135	243	398	443	6
	Tracking Error		6.8%	2.0%	1.2%	0.7%	0.5%	14.9%
	Volatility	18.7%	19.9%	18.6%	18.6%	18.7%	18.7%	26.0%
	Beta	1.00	1.00	0.99	1.00	1.00	1.00	1.15

Data for the Achieving Aligned Aligning and for Paris Aligned were sourced from Leote de Carvalho et al. (2024).

The results in exhibit 4 are based on data as at the end of May 2023. We show that the tracking error of the portfolio invested in AAA stocks is small at only 0.8% for the global portfolios and 0.7% for the MSCI Europe. For the S&P 500, it is higher at 1.2%, but still relatively small. Moreover, the beta is 1 in all cases. From this point of view, systematic active risk exposures in the minimum tracking error portfolios invested in AAA stocks appear relatively well hedged[27]. Thus, we do not expect a significant difference in performance arising from active systematic risk, at least in the medium to long term.

27 Systematic risk is the risk inherent to the entire market, attributable to a mix of factors which explain the co-movement of stock returns, while idiosyncratic risk is the non-diversifiable risk that is specific to each company. Minimum tracking error portfolios use portfolio optimisation to create constrained portfolios where the tracking error against a reference portfolio is minimised by keeping its exposure to the individual risk factors aligned, as much as possible, with that found in the reference portfolio.

If we invested in AA stocks, the tracking errors are still moderately low at 1.3% or 1.4% for global and European stocks. For US stocks, even at 2.0%, it is not too high. For all these minimum tracking error portfolios, we have beta equal to 1. Based on this observation, investing only in achieving and aligned (AA) stocks in minimum tracking error portfolios would have a relatively small impact and could be envisaged to align portfolios more with net zero and a temperature increase at or below 1.5°C above pre-industrial levels.

However, this is no longer the case if we invested only in achieving stocks. Despite the fact that the beta of the minimum tracking error portfolios is close to 1, the tracking errors range from 4.3% for the MSCI ACWI to 6.8% for the S&P 500, which are large. Thus, we can expect significant deviations in performance of minimum tracking error portfolios that invest only in achieving companies relative to the performance of the parent index even if, thanks to a beta of close to 1, those larger excess returns are unlikely to be correlated with the returns of their respective parent indices.

For minimum tracking error portfolios based on the PAB framework, applying all other required constraints including those on decarbonisation and the minimum allocation to emissive sectors, we find small tracking errors in all four cases varying between 0.4% for the MSCI ACWI and 0.8% for the MSCI Europe. This is even smaller than for the AAA portfolios. The beta of the minimum tracking error PAB portfolios is equal to 1. All this indicates that these portfolios should be able to mimic the market cap weighted parent indices over the medium to long term even better than the AAA minimum tracking error portfolios and with an even smaller residual performance thanks to the less restrictive exclusion criteria.

The tracking errors are smaller if we only exclude fossil fuel stocks and, again, the beta of these portfolios is 1. That indicates that such portfolios are likely to mimic the parent indices even better that either the PAB or the AAA minimum tracking error portfolios.

However, the minimum tracking error portfolios invested only in clean energy stocks from the WilderHill Global Clean Energy and WilderHill New Energy Global Innovation indices have quite large tracking errors against their respective market cap weighted parent indices, ranging from 7.7% for the MSCI ACWI index to 14.9% for the S&P 500 index. This is much higher than the minimum tracking error portfolios invested only in achieving stocks. Moreover, the optimiser no longer manages to find portfolios with a beta equal to 1 for the clean energy portfolios: all betas are above 1, which suggests that the excess returns of these minimum tracking error dark green portfolios have a positive correlation with the returns of their respective market cap weighted parent indices, in particular for the US with a beta of 1.15 against the S&P 500 index.

In exhibit 5, we show the sector allocation of the minimum tracking error portfolios based on each framework as at the end of May 2023. The AAA minimum tracking error portfolio and that based on fossil fuel exclusions are the most sector diversified, investing in all sectors. The AA and PAB minimum tracking error portfolios are well diversified in terms of sector allocation, but do not invest at all in energy stocks. The least diversified minimum tracking error portfolios are those investing only in either achieving stocks or clean energy stocks. These portfolios do not invest in communication services, consumer staples, energy, financials and healthcare.

The clean energy portfolio is even less diversified than the achieving portfolio by additionally excluding the real estate sector. These sector biases are likely to generate tracking error and excess returns in the short term which are just based on sector performance.

The information technology sector has the largest weight not only in the US and global market cap weighted indices, but also in the respective minimum tracking error portfolios, even when the number of stocks excluded from this sector is large, as is the case for the A, AA and AAA minimum tracking error portfolios. This suggests that a large allocation to the sector is required to minimise the tracking error relative to the market cap indices, even if at times this allocation may be relatively under-diversified in terms of the number of stocks.

We also find that while the energy sector is excluded from most minimum tracking error portfolios for these frameworks, this sector appears in two cases: portfolios invested in AAA stocks, for which the allocation to the energy sector allocation is close to that in the market cap index, and portfolios with fossil fuel stock exclusions since we have a few energy stocks not classified as fossil fuels stocks.

It is interesting to note that because of the large number of stocks and sectors excluded, the portfolios invested in achieving stocks and clean energy stocks have the largest sector weight deviations relative to the market cap index, in particular a significantly overweighting of the industrials and utilities sectors. That is one of the causes of the larger tracking errors for these minimum tracking error portfolios.

In summary, we can see that the minimum tracking error portfolio for the AAA, PAB and fossil fuel exclusions all have a beta equal to 1, a relatively small tracking error and only small differences in the sector allocation relative to the that in the market cap indices. In the case of the AAA portfolios, there is even an allocation to the energy sector. Therefore, we can expect small differences between the returns of these minimum tracking error portfolios and their respective market cap weighted indices. The minimum tracking error portfolios invested in achieving and aligned stocks (AA) can still be expected to track the returns of the market cap indices relatively well, but these are more likely to show deviations at shorter-term horizons. In turn, the minimum tracking error portfolios invested only in achieving stocks and clean energy stocks are the ones more likely to generate returns different from those of the market cap weighted indices even at medium to longer-term horizons. This is because of their larger sector deviations, tracking errors at levels comparable those seen in actively managed equity funds and, for clean energy, even a beta not equal to 1.

Exhibit 5: Sector allocation of minimum tracking error portfolios

Sector GICS 1	Investment universe	Index	Achieving Aligned Aligning			Paris Aligned	Fossil Fuel Exclusions	Dark Green
			A	AA	AAA	PAB	Not Fossil Fuels	Clean Energy
Commu-nication Services	MSCI ACWI	7.5%		4.9%	3.9%	7.4%	7.7%	
	MSCI World	7.3%		4.4%	3.2%	7.3%	7.5%	
	MSCI Europe	3.3%		5.9%	4.2%	3.2%	3.9%	
	S&P 500	8.7%		4.7%	2.8%	8.9%	9.0%	
Consumer Discretionary	MSCI ACWI	10.7%	4.6%	11.1%	10.9%	11.8%	10.9%	7.4%
	MSCI World	10.5%	4.7%	11.6%	11.1%	10.3%	10.4%	4.9%
	MSCI Europe	11.5%		12.0%	11.2%	11.6%	11.4%	
	S&P 500	10.1%	3.1%	13.0%	10.7%	9.6%	10.1%	7.0%
Consumer Staples	MSCI ACWI	7.5%		7.0%	7.8%	8.7%	8.3%	
	MSCI World	7.7%		6.0%	7.5%	9.0%	8.5%	
	MSCI Europe	12.8%		12.7%	13.2%	13.1%	13.1%	
	S&P 500	6.9%		5.4%	8.0%	7.4%	7.4%	
Energy	MSCI ACWI	4.8%			4.5%		1.8%	
	MSCI World	4.7%			4.5%		1.5%	
	MSCI Europe	5.8%			6.1%		1.1%	
	S&P 500	4.3%			3.3%		1.8%	
Financials	MSCI ACWI	15.5%		13.9%	14.7%	15.6%	15.5%	
	MSCI World	14.7%		13.1%	14.1%	14.7%	14.7%	
	MSCI Europe	17.0%		16.2%	16.4%	17.8%	18.4%	
	S&P 500	12.6%		9.0%	11.8%	12.1%	11.8%	
Healthcare	MSCI ACWI	12.1%		11.8%	11.5%	13.0%	12.4%	
	MSCI World	13.1%		13.0%	12.7%	13.8%	13.4%	
	MSCI Europe	16.1%		15.5%	15.1%	17.3%	16.5%	
	S&P 500	13.6%		13.6%	13.3%	14.6%	14.0%	
Industrials	MSCI ACWI	10.3%	32.9%	11.9%	10.9%	10.9%	10.6%	33.4%
	MSCI World	10.8%	36.5%	12.6%	11.3%	12.3%	11.4%	36.7%
	MSCI Europe	14.9%	45.0%	15.8%	15.0%	16.8%	15.6%	33.0%
	S&P 500	8.3%	42.2%	8.5%	8.5%	9.2%	8.7%	66.2%
Information Technology	MSCI ACWI	21.9%	25.0%	27.0%	26.1%	22.3%	22.3%	8.4%
	MSCI World	22.0%	19.8%	27.1%	26.1%	22.4%	22.3%	5.7%
	MSCI Europe	6.9%	12.0%	7.6%	7.5%	6.9%	6.9%	
	S&P 500	28.0%	3.5%	34.1%	33.6%	29.2%	28.8%	14.5%
Materials	MSCI ACWI	4.6%	4.4%	6.2%	4.3%	5.3%	5.3%	10.8%
	MSCI World	4.1%	2.6%	5.8%	3.7%	5.3%	5.1%	10.4%
	MSCI Europe	6.8%		8.9%	6.4%	8.5%	8.5%	11.1%
	S&P 500	2.4%	3.2%	4.1%	2.5%	4.5%	3.3%	12.3%
Real Estate	MSCI ACWI	2.3%	15.7%	2.5%	2.6%	2.3%	2.4%	
	MSCI World	2.4%	17.2%	2.8%	2.8%	2.3%	2.3%	
	MSCI Europe	0.7%	13.7%	0.4%	0.7%	0.6%	0.4%	
	S&P 500	2.4%	13.8%	3.1%	2.8%	2.4%	2.3%	
Utilities	MSCI ACWI	2.8%	17.4%	3.8%	2.8%	2.7%	2.9%	39.9%
	MSCI World	2.8%	19.2%	3.6%	2.8%	2.8%	2.9%	42.3%
	MSCI Europe	4.2%	29.3%	5.1%	4.2%	4.2%	4.2%	55.9%
	S&P 500	2.7%	34.2%	4.4%	2.8%	1.9%	2.9%	

3.3. IMPACT ON SUSTAINABILITY

In this section, we shall analyse the impact on sustainability performance measures of adopting each of the proposed frameworks while investing in portfolios that minimise tracking error against the respective parent market cap indices.

In exhibit 6, we show the sustainability performance of these same minimum tracking error portfolios as at the end of May 2023 as compared to their respective parent market cap indices. In this table we used BNPP AM datasets based on our proprietary methodologies.

The AAA minimum tracking error portfolios tend to have a higher ESG score than the parent index, except for Europe, which already has the market cap weighted index with the highest ESG score. This is also the case for the PAB framework, the framework based on fossil fuel exclusions and the dark green framework. It is important to mention that no ESG constraints were included in the optimisation. The ESG tilts relative to the respective market cap weighted indices arise simply from the fact the stocks screened tend to have higher ESG scores in each sector.

If we consider the minimum tracking error portfolios invested only in achieving stocks, it is no longer the case that the ESG score is higher than that of the respective parent index, except for European stocks. For global achieving stocks, the ESG score of such a portfolio is similar to that of the parent index, while for achieving US stocks, the score is actually slightly lower.

Exhibit 6: Sustainable characteristics of minimum tracking error portfolios

Investment universe	Description	Index	Achieving Aligned Aligning			Paris Aligned	Fossil Fuel Exclusions	Dark Green
			A	AA	AAA	PAB	Not Fossil Fuels	Clean Energy
MSCI ACWI	ESG	54.3	54.2	59.6	57.2	57.7	56.2	58.6
	CO_2e intensity	72.6	81.1	54.7	62.5	36.3	56.8	39.2
	SI	37.9%	83.0%	46.2%	44.5%	39.6%	38.6%	94.8%
	EU taxo	2.7%	26.9%	5.8%	4.2%	2.7%	2.5%	15.6%
MSCI World	ESG	54.4	54.6	59.3	57.1	57.7	56.4	58.7
	CO_2e intensity	60.6	65.2	45.7	50.3	30.3	44.0	35.7
	SI	38.6%	87.8%	44.9%	43.5%	40.6%	39.4%	94.6%
	EU taxo	2.7%	27.3%	5.3%	3.9%	2.7%	2.5%	16.7%
MSCI Europe	ESG	59.5	63.5	62.4	60.6	61.8	60.5	62.6
	CO_2e intensity	77.7	37.7	91.2	82.6	38.8	70.6	34.9
	SI	55.4%	97.5%	63.8%	57.9%	59.6%	57.8%	92.4%
	EU taxo	2.6%	28.5%	3.6%	2.6%	2.5%	2.1%	15.8%
S&P 500	ESG	53.1	52.0	58.4	56.0	57.0	55.1	53.1
	CO_2e intensity	54.4	101.6	34.5	36.9	27.2	35.0	33.6
	SI	34.0%	74.1%	38.8%	39.0%	37.3%	34.3%	100.0%
	EU taxo	3.1%	26.6%	5.8%	4.4%	3.4%	2.9%	15.2%

Data for the Achieving Aligned Aligning and for Paris Aligned were sourced from Leote de Carvalho et al. (2024).

It is important to highlight that the carbon intensity of the minimum tracking error portfolios invested only in achieving stocks can be higher than that of the parent index, as is the case for global and US stocks. This is largely attributable to the significant overweight of the industrials sector in the achieving portfolio. Many climate solution providers at global level are classified as industrials and have carbon-intensive operations (Scope 1 and 2), but produce products or services which serve to reduce downstream emissions (Scope 3). However, this is not the case in Europe, where of the 25 European companies achieving net zero, only four have a carbon intensity above that of the MSCI Europe.

However, for the AA and AAA minimum tracking error portfolios, it is the European portfolios that have a higher carbon intensity than the parent index. This makes sense as European high emitters are likely more prone to release carbon reduction targets (which are captured by NZ:AAA). In turn, the minimum tracking error portfolios constructed with PAB constraints have the lowest carbon intensity of all the frameworks and a much lower intensity than that of the respective parent indices. This can be explained by the explicit decarbonisation constraints used to construct those portfolios, in particular the constraint to reduce the GHG intensity by at least by 50% relative to the parent index. The dark green minimum tracking error portfolios achieve comparable low levels of carbon intensity. An explicit exclusion of fossil fuels stocks also leads to low levels of carbon intensity in the minimum tracking error portfolios relative to their respective parent indices.

Finally, when it comes to the percentage of companies qualifying as SFDR sustainable investments using BNPP AM's proprietary classification method and the EU taxonomy, the minimum tracking error portfolios invested in achieving stocks and clean energy stocks tend to show the highest allocations, with levels typically above those of the respective parent indices. For all other minimum tracking error portfolios, we find a percentage of sustainable investing and EU taxonomy either just slightly higher or close to that of the respective parent index.

3.4. ALLOCATIONS TO ACHIEVING, ALIGNED, ALIGNING AND FOSSIL FUELS STOCKS

In this section, we investigate the allocation of the different minimum tracking error portfolios to achieving, aligned, aligning and fossil fuels stocks.

In exhibit 7, we show the sum of the weights of stocks classified as achieving, aligned and aligning in the minimum tracking error portfolios of the different frameworks as at the end of May 2023. We also show the sum of the weights of fossil fuel stocks in those same portfolios.

As shown, the market cap index has the largest allocation to aligned stocks, at about 40% for all regions except Europe where it is higher at almost 56%. Aligning stocks make up between 17.9% and 19.9% for the MSCI World index. The allocations to achieving stock are in the range of 3% to 5% and the allocation to fossil fuel stocks is either 10% or just slightly lower for all market cap indices.

The minimum tracking error portfolios invested in AAA stocks overweight significantly aligned and aligning stocks relative to the respective parent indices. They slightly overweight achieving stocks. Despite allocating to fossil fuel stocks, these portfolios tend to underweight them relative to the respecting parent index.

The PAB minimum tracking error portfolios tend to have an allocation to AAA stocks close to that of their respective parent indices. What characterises these portfolios is a significant underweight of fossil fuel stocks. Similarly, the minimum tracking error portfolios with exclusions of fossil fuel companies have allocations to AAA stocks close to those in the parent indices, and obviously, no allocation to fossil fuel companies.

Exhibit 7: Allocation of minimum tracking error portfolios

Investment universe	Description	Index	Achieving Aligned Aligning			Paris Aligned	Fossil Fuel Exclusions	Dark Green
			A	AA	AAA	PAB	Not Fossil Fuels	Clean Energy
MSCI ACWI	Achieving	3.5%	100%	8.7%	6.2%	3.3%	3.3%	57.7%
	Aligned	38.0%		91.3%	57.7%	38.8%	39.1%	13.1%
	Aligning	19.6%			36.1%	18.6%	18.9%	
	Fossil Fuels	9.4%	10.2%	3.5%	8.2%	4.1%		
MSCI World	Achieving	3.6%	100%	7.8%	5.5%	3.4%	3.4%	60.7%
	Aligned	40.8%		92.2%	60.3%	41.5%	41.9%	11.7%
	Aligning	19.9%			34.2%	18.7%	19.1%	
	Fossil Fuels	9.4%	12.1%	3.7%	8.3%	3.2%		
MSCI Europe	Achieving	5.0%	100%	5.1%	5.4%	4.9%	4.2%	78.1%
	Aligned	55.8%		94.9%	70.4%	59.0%	59.0%	21.9%
	Aligning	17.9%			24.3%	13.6%	13.8%	
	Fossil Fuels	10.0%	19.5%	2.4%	9.7%	2.5%		
S&P 500	Achieving	3.0%	100%	7.5%	4.4%	2.8%	2.7%	15.2%
	Aligned	41.7%		92.5%	62.7%	42.3%	42.6%	
	Aligning	18.9%			32.8%	19.3%	20.6%	
	Fossil Fuels	8.6%	17.8%	5.6%	6.5%	1.9%		

Data for the Achieving Aligned Aligning and for Paris Aligned were sourced from Leote de Carvalho et al. (2024).

The dark green clean energy minimum tracking error portfolios overweight significantly achieving stocks relative to the parent indices and in all cases but for the US, they have a small allocation to aligned stocks. This is smaller than what is found in the parent indices. In the case of the US, there is no allocation to aligned stocks. These portfolios neither allocate to fossil fuel stocks nor to aligning stocks.

3.5. STRENGTHS AND WEAKNESSES OF EACH FRAMEWORK

After presenting each framework in section 2 and conducting a comparative analysis in section 3, we shall now discuss the strengths and weaknesses of each approach from our perspective. We have compiled a summary of these strengths and weaknesses in Exhibit 8.

Our assessment of the ability to create a diversified portfolio is based on the information presented in Exhibits 1 through 4. Frameworks that allow for more stocks and exclude fewer sectors will naturally provide stronger diversification. In this regard, the PAB and fossil fuel

exclusion frameworks allow for stronger diversification. As demonstrated, we can construct portfolios with relatively low tracking errors compared to the respective indices, which indicates that it is possible to diversify away most of the active risk. Conversely, investing solely in achieving stocks or clean energy stocks will not result in strong portfolio diversification due to the limited number of stocks available for investment. As a consequence, the tracking error is likely to be influenced not only by stock-specific risk, but even by systematic risk factor exposures such as the absence of certain sectors.

When it comes to the likelihood of the portfolio being aligned with a 1.5°C trajectory to net zero, investing in achieving and aligned companies should achieve this goal as long as companies deliver on their commitments, in line with the framework's design. However, the more we invest in companies classified as aligning, which have a 2°C trajectory to net zero, the less likely this is to happen. On the other hand, investing in companies that concentrate on clean energy can be expected to help finance the energy transition, increasing the likelihood of aligning the economy with a 1.5°C trajectory to net zero. Similarly, companies that are classified as achieving because they offer climate solutions will be contributing to the energy transition and thus to achieving net zero, even if they may have high emissions today.

Exhibit 8: Strenghts and weaknesses of each framework

	Achieving Aligned Aligning			Paris Aligned	Fossil Fuel Exclusions	Dark Green
	A	AA	AAA	PAB	Not Fossil Fuels	Clean Energy
Ability to diversify portfolio	weak	medium	strong	strong	strong	weak
Probability of alignment of portfolio with net zero by 2050	high	high	medium	high	low	high
Immediate decarbonization of portfolio	weak	medium	medium	high	high	high
Account for the different effort of companies to reach net zero	yes	yes	yes	no	no	no
Focus on funding the energy transition	strong	medium	medium	weak	weak	strong
Forward looking approach to net zero	yes	yes	yes	partially	no	yes
Ability to engage and for stewarship with higher impact companies	strong	strong	strong	weak	weak	weak
EU taxonomy exposure	strong	medium	medium	weak	weak	strong

PAB, fossil fuel exclusions, and dark green investing are the most effective approaches for achieving an immediate decarbonisation of the portfolio. In contrast, the NZ:AAA framework may not even reduce the portfolio's carbon intensity today when compared to the market cap index, as shown in exhibit 6. However, this should be seen as a feature of the NZ:AAA framework rather than a weakness.

The PAB rulebook has strict requirements for the emission trajectory, which may not be the most efficient way to reduce cumulative emissions over time. To meet the prescribed decarbonisation rate, PAB strategies may need to reallocate capital to lower-impact industries, even within high-impact sectors. This approach may not encourage companies in high-impact industries to transition to greener operations, decoupling PAB from the real economy. This decoupling may impede genuine progress towards a 1.5°C world and may even leave investors worse off. Achieving net zero in portfolios using a more nuanced framework could be more likely to avoid these unintended consequences.

Considering that companies start their journey to Paris alignment from different places, some may achieve immediate improvements in their carbon profile and then plateau, while others may reduce emissions more gradually over time. Therefore, decarbonisation of the portfolio based on rigid linear rules may be less optimal than an approach applying more nuance.

The net zero paths of companies depend on how far they need to travel from their current business models to achieve alignment with the 1.5°C target. For some companies, the transition will be relatively easy, while for others, the trajectory will be much steeper and more difficult. A best-in-class framework in each sector and region encourages companies from all starting points to make the required incremental changes towards net zero by 2050. Creating a portfolio that supports an economy-wide transition to a 1.5°C world while also avoiding any unintended negative consequences that could hinder this goal is crucial. This is a key advantage of the proposed NZ:AAA framework as it promotes a smooth transition towards net zero while recognising that some companies need to make more of an effort than others.

If we take into account the challenges associated with measuring Scope 3 emissions, investing solely based on emissions may lead to the exclusion of some climate solutions companies with high Scope 1 and 2 carbon intensity. To better align with the net zero transition goals, a strategy which invests explicitly in solutions providers based on what they sell rather than the carbon intensity of their operations is recommended. Both the AAA and dark green investment approaches offer this benefit, but the AAA framework covers a wide range of sectors beyond clean energy.

Moreover, investing capital in assets whose emissions are decreasing over time may be more efficiently accomplished by staying invested in these assets and driving emissions reductions through stewardship and engagement with the companies that need to act the most. This can be one of the most effective ways to drive real-world impacts within public equity investments. For the PAB, exclusion of fossil fuels, and dark green frameworks, there are limited leverage points for engagement. In contrast, the NZ:AAA allows for targeted and nuanced conversations with companies in specific sectors and regions, which can lead to a focus on their future decarbonisation strategy rather than relying solely on their past decarbonisation performance.

Finally, while the NZ:AAA framework is based on current and forward-looking alignment criteria that aim to capture the transition potential of companies, this is less the case for PAB which relies primarily on past carbon data for companies and does not consider their

anticipated future trajectory. And while the annual increase in required decarbonisation can be seen as forward looking, as explained by Bolton, Kacperczyk and Frédéric Samama (2022), the annual 7% carbon reduction specified in the PAB regulation should be adjusted to take into account the inception date and reflect the fact that the remaining carbon budget is finite and depleting rapidly. In that sense, a PAB index created today requires a much faster rate of decarbonisation to still achieve net zero by 2050 than one which has been implemented since 2019.

4. ALIGNMENT WITH NET-ZERO RECOMMENDATIONS

In this section we discuss the alignment of the net zero frameworks with the recommendations of different organizations which have as their mission the decarbonisation of the economy and achieving net zero emissions by 2050 and beyond. In particular, we consider the UN High Level Expert Group (HLEG), the Institutional Investors Group on Climate Change (IIGCC), the UN-convened Net-Zero Asset Owner Alliance, and the Glasgow Financial Alliance for Net Zero (GFANZ).

4.1.UN HIGH LEVEL EXPERT GROUP (HLEG) ON THE NET-ZERO EMISSIONS COMMITMENTS OF NON-STATE ENTITIES

On 31 March 2022, the UN established the High-Level Expert Group (HLEG) on the Net-Zero Emissions Commitments of Non-State Entities to develop stronger and clearer standards for net-zero emissions pledges by non-state entities – including businesses, investors, cities, and regions – and speed up their implementation.

In November 2022, the HLEG published five principles and 10 recommendations for business, financial institutions, cities and regions[28].

The five principles ask for ambition at short and medium-term emission reductions targeting net zero by 2050, integrity by aligning commitments with actions and investments, transparency, credibility through plans based in science and third-party accountability, and commitment to both equity and justice in all actions.

The 10 recommendations go into more detail on what is expected from net zero commitments.

The first and second recommendations are about announcing a net zero pledge and setting the net zero targets, respectively. Pledges and targets should be consistent with the latest the Intergovernmental Panel on Climate Change (IPCC)[29] or IEA net zero pathways that limit warming to 1.5°C with no or limited overshoot, and with global emissions declining by 50% by 2030, reaching net zero by 2050 and net zero GHG emissions soon after. The pledges should include targets for 2025, 2030 and 2035.

28 https://www.un.org/sites/un2.un.org/files/high-level_expert_group_n7b.pdf
29 https://www.ipcc.ch/

The third recommendation asks non-state actors to prioritise an urgent and deep reduction of emissions across their value chain, and to use high-integrity carbon credits[30] in voluntary markets for mitigation beyond the value chain.

The fourth recommendation requires non-state actors to create a transition plan, reported annually and updated every five years, publicly disclosing their actionable net zero transition plans and detailing their planned actions, which should include aligning governance and incentive structures, capital expenditures, research and development, skills and human resource development, and public advocacy.

In their fifth recommendation, the HLEG asks that details about the phasing-out of fossil fuels and the scaling-up of renewable energy are included in all net zero pledges including specific targets aimed at ending the use of and/or support for fossil fuels in line with the same constraints on pathways, interim targets by 2030 and net zero by 2050 and beyond described above. The transition away from fossil fuels is expected to be just for affected communities, ensuring access to energy and avoiding transference of fossil fuel assets to new owners, and thus should be matched with a fully funded transition to renewable energy.

In their sixth recommendation, the HLEG expects non-state actors align their external policy and engagement efforts, including membership of trade associations, to the goal of reducing global emissions by at least 50% by 2030 and reaching net zero by 2050 and beyond. This means lobbying for positive climate action and not against it.

The seventh recommendation is about material land-use emissions, requiring that operations and supply chains avoid the conversion of remaining natural ecosystems, eliminating deforestation and peatland loss by 2025, and the conversion of other remaining natural ecosystems by 2030. Funding of businesses linked to deforestation and agricultural commodity-driven deforestation should be stopped and removed from financial institutions' portfolios by 2025 as part of their net zero plans.

The eighth recommendation is about transparency and accountability, asking non-state actors to disclose annually their GHG emissions data, net zero targets and the plans for meeting those targets on public platforms that feed into the UNFCCC Global Climate Action Portal.

Their ninth recommendation is about achieving net zero with a just transitions and sustainable development, requiring corporations and financial institutions to work with governments to take more risk and set targets to scale investments in the clean energy transition in developing countries.

Finally, the tenth recommendation is for regulators, expecting them to accelerate regulation and standards in areas including net zero pledges, transition plans and disclosure, starting with high-impact corporate emitters, and to challenge fragmented regulatory regimes.

30 https://icvcm.org/

Overall, we can expect that the more we see businesses and financial institutions adopt these recommendations, the greater the number of companies that will be encouraged to achieve net zero. In the meantime, the NZ:AAA framework is one way of classifying companies in terms of how aligned they are with the recommendations of the HLEG, in particular with the recommendations about pledges, setting targets, transition away from fossil fuels, creating a transition plan and disclosing actionable plans. However, the recommendations from the HLEG go beyond the KPIs currently checked by the NZ:AAA framework. Points such as corporate lobbying alignment with net zero outcomes are covered by the work of organisations such as Influence Map[31] and included in the dashboard produced by Climate Action 100+[32]. On this, the Global Standard on Responsible Climate Lobbying project[33], instigated by AP7, BNP Paribas Asset Management and the Church of England Pensions Board in a process supported by Chronos Sustainability, issued 14 indicators[34] intended to be applied consistently across all regions and sectors, with companies taking responsibility for the impact of their advocacy. Corrective action is expected where there is misalignment with the goals of the Paris Agreement on climate change.

4.2. INSTITUTIONAL INVESTORS GROUP ON CLIMATE CHANGE (IIGCC)

As mentioned in section 2, the PAII was launched by the IIGCC in May 2019 to explore how investors can align their portfolios with the goals of the Paris Agreement. One key achievement of the PAII are the Net Zero Investment Framework (NZIF) guidelines[35] published in March 2021 and embraced by the IIGCC (Europe), Ceres (North America), the Asia Investment Group on Climate Change and the IGCC (Investor Group on Climate Change, Australasia). These four networks are supporting investors globally representing in excess of USD 50 trillion to implement the NZIF framework 1.0. The two key objectives of the framework are i) to decarbonise investment portfolios in a way that is consistent with achieving global net zero emissions by 2050 and ii) to increase investment in the range of climate solutions needed to meet that goal.

The PAII explicitly suggests that investors are not expected to meet the PAB requirements. In its view, these are too aggressive in terms of initial emissions intensity reduction. Instead, the PAII prefers to incentivise the allocation of capital to assets whose emissions are declining over time and to climate solutions. It believes that net zero is more likely effectively achieved by maintaining investment in assets where there is an opportunity to maximise real world impacts by driving emission reductions in companies that need to transition through stewardship and engagement, rather than initially excluding companies to achieve an immediate ambitious emissions reduction target.

The BNPP AM NZ:AAA framework is largely inspired by the PAII's NZIF framework 1.0 with minor differences. Our framework has only four categories versus five for PAII and introduces a climate product/service dimension that does not exist in the PAII framework. In terms of implementation, the NZIF advises investors to consider divestment or exclusion i) as

31 https://ca100.influencemap.org/
32 https://www.climateaction100.org/
33 https://climate-lobbying.com/about/
34 https://climate-lobbying.com/wp-content/uploads/2022/03/2022_global-standard-responsible-climate-lobbying_APPENDIX.pdf
35 https://www.parisalignedassetowners.org/media/2021/03/PAII-Net-Zero-Investment-Framework_Implementation-Guide.pdf

a consequence of a climate financial risk assessment, ii) as a consequence of escalation following engagement or iii) for companies whose primary activity is no longer considered permissible within a credible pathway towards net zero, e.g., companies which are planning or constructing new thermal coal projects and associated infrastructure (power, mining) or taking forward new exploitation of tar sands.

It also advises to have an engagement goal to ensure at least 70% of financed emissions in material sectors are either net zero, aligned to a net zero pathway, or the subject of direct or collective engagement and stewardship actions.

In terms of portfolio construction using an alignment framework, it proposes a number of guidelines which include:

- Overweighting good performers and underweighting poor performers within a sector based on alignment criteria and climate solutions revenues
- Using specialist benchmarks, products or funds focused on alignment and climate solutions.

In terms of engagement and stewardship, the PAII provides a number of guidelines including:

- Publishing a voting policy aligned with the NZIF framework
- Setting an engagement strategy with milestones and an escalation process with a feedback loop to investment, weighting, and divestment decisions
- Prioritising engagement efforts based on carbon intensity relative exposure
- Informing companies of expectations in relation to alignment criteria
- Joining and playing an active role in collective engagement initiatives
- Publishing voting records, and a rationale for deviating from policy.

Specific guidelines for listed equity are proposed including using annual general meetings for escalation when necessary, voting against the board, remuneration policy, annual report and accounts for companies which are not on track to achieve their transition plans or targets set for two years, or voting against mergers and acquisitions that do not meet the required criteria.

4.3. UN-CONVENED NET-ZERO ASSET OWNER ALLIANCE

The UN-convened Net-Zero Asset Owner Alliance (NZAOA)[36] is a members-led initiative of institutional investors with USD 11 trillion under management committed to transitioning their investment portfolios to net zero by 2050, consistent with a maximum temperature rise of 1.5°C above pre-industrial levels.

The NZAOA welcomes the introduction of PABs by the EU, but believes that additional customisation on top of the PAB indices commercially available may be required because asset owners typically have diverse investment strategies. In particular the NZAOA worries that i) an asset owner could be managing assets for policyholders who expect to receive

36 https://www.unepfi.org/net-zero-alliance/

returns commensurate to a broad traditional-market index, ii) that commercially available PAB indices may have a large tracking error relative to market cap indices[37] and that this could even grow over time and iii) that members of schemes or mandates have differing investment horizons, risk and returns expectations, and/or decarbonisation targets.

Thus, the NZAOA set out 10 key principles for net zero aligned benchmarks[38] that should be considered by asset owners. As we shall see below, some of the principles go along similar lines as those proposed by the PAII in their NZIF framework 1.0.

The first simply asks for transparency in the methodology and design of net zero benchmarks, while the second principle proposes the starting point for a decarbonisation trajectory should be set by the asset owner, at least when new indices are created.

The third principle asks for no mechanical exclusions of high-emitting countries of sectors, except for thermal coal. The NZAOA believes that exclusions of high-emitting sectors or constituents are not necessary to achieve decarbonisation objectives. Rather, benchmarks should tilt the weights in favour of the decarbonisation leaders. It also believes that a while a no exclusions framework may lead to smaller decarbonisation advances at the onset, the delay can be compensated for by a steeper year-on-year decarbonisation pathway. In any case, this clearly would exclude a strategy based on just fossil fuel exclusions or any PAB framework with such type of exclusions.

The fourth principle asks for net zero-aligned indices to correspond to real economy decarbonisation. The NZAOA expects net zero indices to be based on assessing whether companies' short- and mid-term transition plans align to 1.5°C pathways and recommends that companies decarbonisation plans should be credible and aligned with science-based no or limited overshoot 1.5°C sector pathways to ensure positive real world outcomes. We find this principle consistent with using a AAA type assessment of companies as proposed in section 2. Also, this feature is not in the EU PAB regulation and would need to be added to PAB indices if they were to be in line with this principle.

The fifth principle asks for the difference in speed of decarbonisation across sectors and geographies to be taken into account, instead of assuming a uniform decarbonisation percentage - for example 7% - which the NZAOA believes may be either punitive or lax depending on the sector and country. Thus, according to the NZAOA, net zero benchmarks should consider differences in the pace of decarbonisation, much like the IEA 1.5°C[39] and OECM[40] sector models do. Phasing out fossil fuels should be in line with the relevant scenarios. In all, this principle seems to us to again be consistent with the use of an NZ:AAA framework and introduces even stronger constraints on PAB indices to the point that it could make them irrelevant for NZAOA members.

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37 In this paper we use PABs with only the minimum required regulatory constraints applied. Our results tend to show a low tracking error of these PABs relative to market capitalization weighted benchmark indices. However, the commercially available PAB indices usually apply a number of additional constraints which increase their tracking error and concentration.

38 https://www.unepfi.org/industries/development-and-uptake-of-net-zero-aligned-benchmarks-a-call-to-action-for-asset-owners-and-index-providers/

39 https://www.iea.org/reports/credible-pathways-to-150c

40 https://www.unepfi.org/industries/investment/one-earth-climate-model-sectoral-pathways-to-net-zero-emissions/

The sixth principle expects NZAOA members to rely on forward-looking indicators as a key input in the decarbonisation process. Such indicators should measure whether companies are committed to achieving net zero by 2050, pursuing serious short or medium-term absolute and intensity decarbonisation targets, verified by the SBTi, allocating capital dedicated to decarbonisation projects, reporting in accordance with recommendations of the TCFD[41], etc., again consistent with the NZ:AAA framework proposed. This would be yet another constraint on PABs.

The seventh principle recommends that to enable reporting and customisation, climate key performance indicators (KPIs) such as carbon intensity, carbon footprint and transition plans should be available at the constituent level, and that asset owners should be able to easily customise standard indices as needed, while the eight principle is about the need to address the lack of data adequately, in particular avoiding using sector or country averages for companies not publishing data. The NZAOA recommends a penalising mechanism for those issuers that fail to provide their data, which is the case for the NZ:AAA framework described in section 2.

The final two principles require that key metrics such as turnover, credit rating and duration should be comparable to the parent index to ensure broad implementation and ask for climate KPIs to include multiple factors directly tied to inclusive climate finance such as equitable employment in the climate economy, equitable access to affordable clean energy, decarbonisation pathways that reduce inequalities, and inclusive investment in climate-resilient infrastructure and technology.

Overall, we believe that members of the NZAOA should be able to implement net zero strategies complying with these principles while using a NZ:AAA framework as described in section 2 or by adding constraints to PAB indices using AAA assessments (or beyond, for principle 9 on the just transition). Nevertheless, principle five appears to discourage the use of PABs because of the expected rapid decarbonisation, which is not necessarily consistent with implementing a framework allowing for different speeds of decarbonisation across sectors and geographies. Finally, unlike the NZIF guidelines of the PAII, the principles of the NZAOA are relatively vague about engagement and stewardship.

4.4. GLASGOW FINANCIAL ALLIANCE FOR NET ZERO (GFANZ)

The Glasgow Financial Alliance for Net Zero[42] was created in April 2021 by the UN Special Envoy on Climate Action and the COP26 presidency in partnership with the UNFCCC Race to Zero campaign. GFANZ is a global coalition of 500 leading financial institutions from more than 50 countries committed to accelerating the decarbonisation of the economy and has two missions, i) to expand the number of net zero-committed financial institutions and ii) to establish a forum for addressing sector-wide challenges associated with the net zero transition. GFANZ represents seven financial sector net zero alliances (including NZAOA, Net Zero Asset Manager initiative (NZAM)[43], the Net Zero Banking Alliance (NZBA)[44], each having its own governance structure).

41 https://www.fsb-tcfd.org/
42 https://www.gfanzero.com/our-work/financial-institution-net-zero-transition-plans/
43 https://www.netzeroassetmanagers.org/
44 https://www.unepfi.org/net-zero-banking/

In its 2022 Net-zero Transition Planning[45], GFANZ proposes voluntary guidance for financial institutions to use portfolio alignment metrics. The guidance presents a broad pan-sector framework for portfolio alignment measurement and metric selection. Each financial institution is encouraged to use elements of the guidance based on considerations such as its target audience for disclosures and the contractual and regulatory environment within which it operates.

However, the report does not intend to provide prescriptive guidance on specific methods. GFANZ believes that each financial institution should determine its own framework for portfolio alignment measurement and metrics. Additionally, GFANZ acknowledges that supporting pathways, tools and methodologies may not yet be available for all situations. It expects this to change over time as financial institutions develop and execute net zero transition pathways.

In view of this, we believe that GFANZ is agnostic at this stage when it comes to defining a net zero strategy.

4.5. NET ZERO ASSET MANAGERS INITIATIVE (NZAM)

The Net Zero Asset Managers initiative (NZAM) is a global group of asset managers that committed to achieving net zero GHG emissions by 2050 or earlier to limit global warming to 1.5°C above pre-industrial levels. Launched in December 2020 with 30 initial signatories, this initiative is convened by six investor networks: AIGCC (Asia), Ceres (North America), IGCC (Australasia), IIGCC (Europe), CDP (Global), and UN PRI (Global). The initiative had 273 signatories and over USD 61 trillion in assets under management as of 31 May 2022.

Signatories are required to disclose the initial percentage of their portfolio that will be managed in line with net zero, disclose the methodology used in target setting, and set interim targets for assets managed in line with net zero for 2030, consistent with a fair share of the 50% global carbon reduction. They should review interim targets at least every five years. They must make sure that any relevant direct and indirect policy advocacy is supportive of achieving global net zero emissions by 2050 or sooner.

Signatories are expected to prioritise real economy emissions reductions, consider material Scope 3 emissions when possible, increase investment in climate solutions, create investment products in line with net zero and agree to use only offsets that involve long-term carbon removal where there are no technologically and/or financially viable ways to eliminate emissions.

Signatories must provide clients with information and analytics on net zero investing and climate risks and opportunities and work in partnership with them on decarbonisation goals, aiming for net zero emissions by 2050 or sooner across all assets under management.

45 https://assets.bbhub.io/company/sites/63/2022/10/GFANZ_Towards-a-Global-Baseline-for-Net-Zero-Transition-Planning_November2022.pdf

Additionally, signatories should implement a stewardship and engagement strategy with clear escalation and voting policies consistent with achieving net zero by 2050 or sooner and applied to all assets under management. Engagement with actors key to the investment system including credit rating agencies, auditors, stock exchanges, proxy advisers, investment consultants, and data and service providers is expected to ensure that products and services available to investors are consistent with the goal of achieving net zero emissions by 2050 or sooner.

Finally, signatories should publish disclosures as proposed by the Task Force on Climate-Related Financial Disclosures (TCFD) including an annual climate action plan and submit them to the Investor Agenda for review to ensure the approach applied is based on a robust methodology consistent with the UN Race to Zero criteria.

As seen above, NZAM is relatively open when it comes to the actual framework used to achieve global net zero emissions by 2050 or sooner and puts the focus on disclosing, engaging, partnering with clients, defining interim targets and making sure that the climate action plan is robust and delivered. In that sense, asset managers are free to use a combination of frameworks for products provided that the sum will put them on the path to delivering net zero emissions by 2050 or sooner on all assets under management.

5. ANALYSIS LIMITATIONS AND FURTHER RESEARCH

As with any analysis relying upon quantitative tools for the assessment of performance impacts, caveats are warranted in determining the interpretation of the results. First of all, our analysis is based on portfolios constructed on a single date relying on current and recent historical data. Of course, this is not necessarily representative of the future, knowing that portfolios will be sensitive to how fast companies align with net zero pathways, how fast the transition to clean energy will occur, and that portfolios will have to be rebalanced periodically. In an optimistic scenario where all stays on track to net zero by 2050, the minimum tracking error portfolios constrained to investing in either NZ:AAA or PAB, or excluding fossil fuel companies, should converge towards the market cap portfolio as we get closer to 2050. In turn, clean energy should simply become mainstream. However, a delayed transition could lead to higher tracking errors than those shown here if not enough companies align with their net zero pathway fast enough and, as a result, the number of excluded companies grows over time.

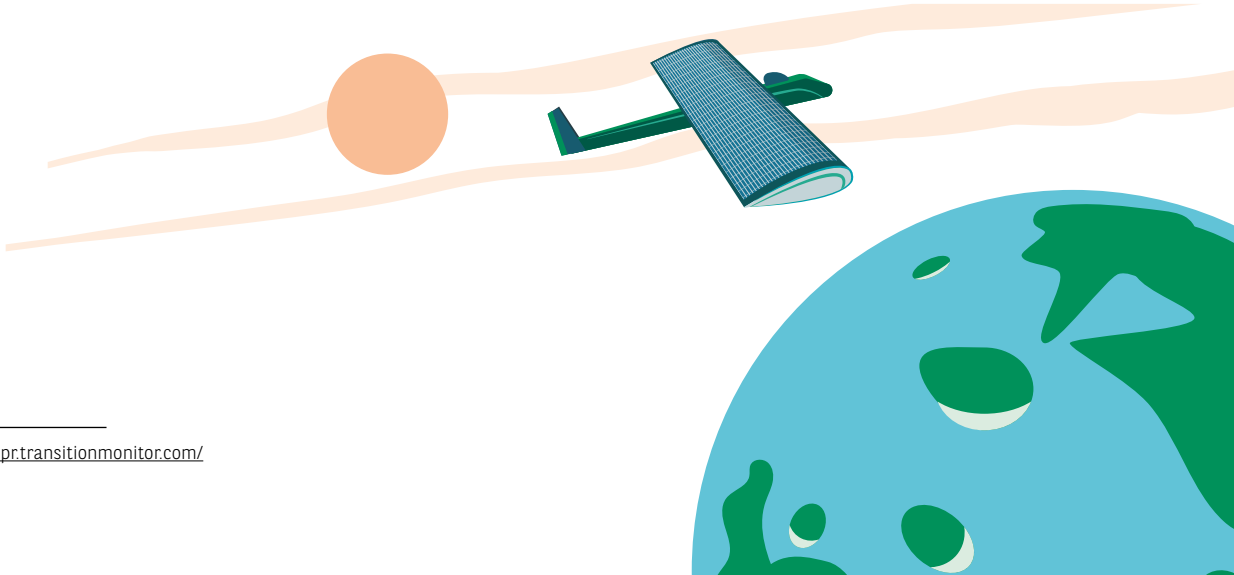
Additionally, we recognise that current quantitative analytical frameworks have limitations when it comes to understanding the potential impact of climate change on portfolios. The above caveat is therefore doubly relevant in a future which looks different from the past. That said, we would expect that a portfolio which has been explicitly conditioned to address climate change risks (e.g., a NZ:AAA portfolio) is more likely to outperform in a scenario where a low carbon transition occurs[46], even if this expected outperformance has not been included in our discussion.

46 https://info.mercer.com/rs/521-DEV-513/images/Climate-change-the-sequel-2019-full-report.pdf

Indeed, if there is a positive net zero risk premium, the approach used here to minimise the tracking error of portfolios against the market cap index while constraining it to invest in AA or AAA companies should outperform the market cap index in the medium to longer-term. However, it is reasonable to ask whether, if a positive net zero risk premium exists, minimum tracking error portfolios would be the most appropriate allocation for investors. This is not necessarily so, at least not for all investors. Indeed, investors convinced about the speed and strength of the low carbon transition should consider approaches which involve higher active weights versus parent indices. While the minimum tracking error portfolios are minimum variance efficient, they do not take into account any views on expected returns. In this case, they actually minimise the risk budget allocated to a net zero risk premium against the market cap portfolio. Moreover, they rely on the standard deviation of excess return against the market cap index as the primary measure of risk, which may not be the most relevant risk dimension when investing for net zero as the probability of extreme events (e.g., an abrupt or delayed transition) may need to be considered.

Still, minimum tracking error portfolios offer a feasible solution that is likely to be useful for a large number of investors, in particular institutional investors, i.e., those with significantly large portfolios who tend to set constraints on the amount of tracking error risk they can accommodate relative to the market cap portfolio. It is also a pragmatic solution that can be used for as long as we do not have a good enough estimation of the net zero risk premium, which is required if we were to better size the risk budget allocation to that premium.

Going forward, it is clear that we should welcome further research which aims to quantify the potential risk premium associated with investing for net zero, and to let investors use frameworks where they comfortably take on active risk by implementing a portfolio based on whatever future climate scenario is anticipated to unfold, for example, accommodating the sector tilts reflected in the Forecast Policy Scenario of the Inevitable Policy Response initiative[47]. This requires further integration of climate scenarios into portfolio analysis and possibly moving away from the use of myopic mean-variance based tools such as minimum tracking error portfolios which rely on historical data for risk and fail to accommodate extreme risk events. In addition, it would be beneficial to undertake an analysis similar to that in this paper looking at the implications of different net zero portfolio approaches in the context of fixed income and private asset portfolios.



47 https://ipr.transitionmonitor.com/

6. CONCLUSIONS

This paper explores various frameworks for achieving net zero pathways in investment portfolios. We presented four specific frameworks, namely using Achieving, Aligned, Aligning (NZ:AAA) screens, the Paris Aligned Benchmark (PAB) rules, fossil fuel exclusions, and clean energy thematic investing. We discussed the merits and weaknesses of each framework in terms of investment risk and portfolio construction, and how they can match the current ambitions of institutional investors when it comes to steering portfolios to meet their own net zero commitments.

The achieving screens recognise companies that are already achieving the emissions intensity necessary for net zero by 2050 and/or are selling products and services aligned with that goal. Aligned screens identify companies that are essentially on a net zero 1.5°C pathway, while aligning screens identify companies on a 2.0°C pathway. The AAA classification is based largely on forward-looking data and places less emphasis on achieving high levels of decarbonisation today, enabling investors to identify and engage with and steward high-emitting companies. It also maintains exposure to climate solutions providers.

The PAB framework, on the other hand, focuses primarily on strong decarbonisation by reducing the carbon intensity of portfolios relative to the market cap weighted index and establishing a trajectory to continue reducing the carbon intensity every year until 2050. When considering only the EU regulation for PABs, this framework is based on historical emissions data and does not include a forward-looking dimension. Similarly, fossil fuel exclusions are effective at significantly reducing carbon intensity today by simply excluding companies that are currently responsible for most of the GHG emissions. PAB and fossil fuel exclusions do not support engagement and stewardship with many higher emitters since they involve divesting from them, without clarity that this divestment will lead to the closure of associated plants and thus the reduction of real world emissions. On the other hand, clean energy thematic investing is an effective approach for investing in companies that produce or distribute clean energy technologies.

Our analysis identifies the strengths and limitations of each framework and suggests that investors should carefully consider their investment objectives and risk tolerance when selecting a framework for net zero investing. We examine the expected impact of each framework on the breadth of the investment universe, the market capitalisation available for investing, and the regions and sectors in which investments can be made. Finally, we investigate the impact on risk and the ability to track the original index performance while investing for net zero using minimum tracking error strategies against market cap indices. We explore the opportunity for each framework to contribute to net zero outcomes.

Finally, we discuss how the different frameworks align with the recommendations of various organisations that focus on financial sector alignment with net zero by 2050. We find that the recommendations from the UN High Level Expert Group (HLEG) on the Net-Zero Emissions

Commitments of Non-State Entities could be the most ambitions and if implemented by businesses would accelerate the transition and constrain investing for net zero less.

Our NZ:AAA framework can identify companies that broadly meet the recommendations, particularly by focusing on achieving and aligned companies. We find that the NZ:AAA framework is best suited for constructing portfolios that align with the Net Zero Investment Framework (NZIF) recommendations issued by the Institutional Investors Group on Climate Change. The other three frameworks fall short of meeting several NZIF recommendations, particularly due to their aggressive decarbonisation and divestment from high-impact companies, making engagement and stewardship with those companies more challenging. Additionally, we find that the NZ:AAA framework aligns well with the recommendations of the UN-convened Net-Zero Asset Owner Alliance. Members striving to follow all the recommendations may consider a constrained PAB framework. Finally, the Glasgow Financial Alliance for Net Zero approach is the most flexible and can accommodate a focus on some or all of the different frameworks proposed.

Regardless of the implementation framework selected, it is clear that reasonably diversified portfolios with a low tracking error can be constructed, which shows that investors can likely align their equity portfolios with net zero without unduly compromising their fiduciary obligations. In practice, many investors will likely use a combination of the frameworks studied in this paper across their public and private investment allocations to equity, fixed income, private markets and other asset classes.

To conclude, we believe that institutional investors have a crucial role to play in driving the transition to a net zero emissions future. This paper helps to illustrate and clarify the strengths and weaknesses of various known frameworks for investing in net zero by 2050 and to understand their alignment with recommendations from organisations that aim to decarbonise the economy and achieve net zero emissions by 2050 and beyond.

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8. APPENDIX

The EU 2020/1818 regulation[48] with the minimum standards for EU Climate Transition Benchmarks and EU Paris-aligned Benchmarks includes a number of articles with the guidance for constructing them. For PAB, these can be divided into:

A. Articles about the methodology of calculation:

- Article 4: Calculation of GHG intensity
  - calculate the GHG intensity using the same currency for all assets,
  - recalculate the GHG intensity on annual basis.
- Article 5: Phase-in of Scope 3 GHG emissions data in the PAB methodology
  - include Scope 3 for at least the energy and mining sectors,
  - within 2 years include Scope 3 for at least the transportation, construction, buildings, materials and industrial sectors,
  - within 4 years include Scope 3 for all other sectors.
- Article 8: Change in GHG intensity and absolute GHG emissions
  - as the % change between the portfolio weighted average GHG intensity or absolute emissions of all constituents of the EU PAB at the end of year n versus the same at the end of year n-1.

48 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R1818

B. Articles with compulsory criteria:

- Article 3: Equity allocation constraint
  - Allocation to sector Sections A to H[49] and Section L of Annex I to Regulation (EC) No 1893/2006 that is at least equivalent to the aggregated exposure of the underlying investable universe to those sectors
- Article 7: Setting a decarbonisation trajectory
  - decarbonisation trajectory of at least 7% reduction50 of average GHG intensity p.a.
  - targets calculated in a geometric progression from the base year
  - if the average EVIC51 of the benchmark changed in the last calendar year, then each constituent's EVIC is adjusted by dividing it by an enterprise value inflation adjustment factor52
- Article 11: Baseline reduction of GHG intensity
  - The GHG intensity including Scope 1 and 2 (and 3 as in article 5) shall be at least 50 % lower than the GHG intensity of the investable universe
- Article 12: Exclusions for EU PAB
  - companies involved in any activities related to controversial weapons,
  - companies involved in the cultivation and production of tobacco,
  - companies that benchmark administrators find in violation of the UNGC principles or the OECD Guidelines for Multinational Enterprises,
  - companies that derive 1% or more of their revenues from exploration, mining, extraction, distribution or refining of hard coal and lignite,
  - companies that derive 10% or more of their revenues from the exploration, extraction, distribution or refining of oil fuels,
  - companies that derive 50% or more of their revenues from the exploration, extraction, manufacturing or distribution of gaseous fuels,
  - companies that derive 50% or more of their revenues from electricity generation with a GHG intensity of more than 100 gCO2e/kWh,
  - companies that are found or estimated by them or by external data providers to significantly harm one or more of the EU environmental objectives.

C. Articles with voluntary criteria:

- Article 6: weight of stocks that set and publish GHG emission reduction targets can be increased if those companies:
  - publish consistently and accurately their Scope 1 and 2 (and 3 as in article 5) GHG emissions
  - have reduced their GHG intensity or absolute GHG emissions, including Scope 1 and 2 (and 3 as in article 5) by an average of min 7% p.a. for at least 3 consecutive years.

The use of a *green to brown share ratio* is not explicitly included in the regulation as those notions had not yet been defined at EU level at the time of publication. However, it is recommended and can be found in some versions of commercially available PAB. Other criteria that can also be found in commercially available PAB but are not required by the regulation include constraining the final ESG score of the PAB or constraining the weight of stocks with the highest energy transition risk.

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49 Section A: Agriculture, Forestry and Fishing; Section B: Mining and Quarrying; Section C: Manufacturing, Section D: Electricity, Gas, Steam and Air Conditioning Supply; Section E: Water Supply, Sewerage, Waste Management and Remediation Activities; Section F: Construction; Section G: Wholesale and Retail Trade; Section H: Transportation and Storage; Section L: Real Estate Activities.

50 For public equities

51 EVIC stands for 'Enterprise Value Including Cash', defined as the sum of the market capitalization of ordinary shares at fiscal year end, the market capitalization of preferred shares at fiscal year-end, and the book values of total debt and minorities' interests. No deductions of cash or cash equivalents are made to avoid the possibility of negative enterprise values

52 Inflation adjustment factor = (average EVIC of benchmark at the end of calendar year) / (average EVIC of the benchmark at the end of previous calendar year)

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