2024 Analysis of Climate Change and Nature-Related Risks in the GPIF Portfolios

MSCI ESG Research LLC

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Contents

Executive summary **3**
Analysis of climate-change-related risks **5**
Status of companies' climate targets based on MSCI target-level data 5
Status of companies' scope 1 and 2 and some scope 3 emissions disclosure rates 7
Analysis of corporate GHG emissions and climate targets by scope 8
Analysis of corporate climate target credibility 11
Impact analysis using ITR 13
Climate-change-related risks for portfolios 19
Analysis of equity and corporate bond portfolio 22
Analysis of sovereign bond portfolio 27
Analysis of nature-related risks **30**
Introduction 30
Nature risk can turn into business risk 30
A new regulatory focus 30
A new milestone in global disclosure: The TNFD framework 31
Nature risk is investment risk 32
Overcoming the data challenge 33
Geospatial mapping of GPIF assets against biodiversity-sensitive areas 34
Materiality assessment: Identifying high-risk industries 36
Deforestation 42
Biodiversity footprinting 43
Company awareness 45
Nature opportunities 47
Appendix **49**

Executive summary

This paper uses information derived from MSCI's analytical tools to provide an analysis of climate-related and nature-related investment risks and impacts on the portfolios of the Government Pension Investment Fund (GPIF). For the analysis of climate-related risks and impacts, we cover issues such as the state of corporate carbon emissions disclosures, target setting, portfolio alignment and investment risks for equity, corporate bond, and sovereign bond portfolios. For the analysis of nature-related risks and impacts, we identify industries that may face high risks related to nature and biodiversity, especially in biodiversity-sensitive areas, among other issues. Wherever possible, we conducted historical comparisons with the past GPIF analysis[1] and comparisons to relevant benchmarks.

Our main conclusions are as follows:

Analysis on climate-change-related impact using Implied Temperature Rise (ITR)

- Portfolio-level ITR value[2] of the GPIF portfolios slightly improved to 2.4°C in FY2023 from 2.5°C in FY2022. This is mainly driven by the fact that more companies in the portfolios have set climate targets, including Science Based Targets initiative (SBTi)-approved targets during the same period.
- The GPIF ITR values would improve by 0.1°C to 2.3°C (taking target at face value) from 2.4°C (incorporating target credibility assessments). The difference is attributed to our target credibility assessment, which resulted in discounting some companies' target-based emissions projections based on target credibility weights in our model. This translated to higher ITR values.

Analysis on climate-change-related risks

- Under a 1.5°C Disorderly (Divergent Net-Zero) scenario, GPIF's total portfolio (corporate equity and bond) had the largest positive Climate Value-at-Risk (Climate VaR) among other scenarios due to its relatively high technology opportunities, which offset its policy risks at portfolio levels. Among four asset classes (domestic equity, foreign equity, domestic corporate bond and foreign corporate bond), domestic equity portfolio showed the largest technology opportunity Climate VaR, especially under the 1.5°C scenario. This was partly driven by a relatively high low-carbon-patent score. Domestic equity portfolio could face a relatively larger negative physical risk Climate VaR than the other asset classes in higher temperature scenarios.
- Using the MSCI Sovereign Bond Climate VaR, we found GPIF's sovereign bond portfolio had the largest negative return in the 1.5°C Disorderly (Divergent Net-Zero) scenario compared to the results under other scenarios, as the analysis of Sovereign Bond Climate VaR focuses on transition risks rather than opportunities. While the order of scenarios by profit and loss (PnL) impact remained the same as in FY2022—with the 1.5°C Disorderly (Divergent Net-Zero) scenario continuing to show the largest negative return—we observed an improvement

[1] MSCI ESG Research LLC. "2023 Analysis of Climate Change-Related Risks in the GPIF's Portfolios." July 2023.

[2] We aggregate all companies' projected emissions and carbon budgets using an attribution factor based on the Partnership for Carbon Accounting Financials (PCAF) framework. According to the framework, if a portfolio finances e.g. 5% of a company's enterprise value including cash (EVIC), it "owns" (i.e., finances) 5% of this company's projected emissions and 5% of this company's carbon budget — and therefore, 5% of this company's over- or undershoot.

in the negative PnL for FY2023 compared to the previous year. Possible reasons behind this trend may be attributed to shortened durations.

Analysis of nature-related risks

- Analysis on biodiversity-related risks can be inherently more complex and multifaceted and require geospatial analysis. However, the state of data and models is improving rapidly. Our analysis, which requires combining a heterogeneous data set, shows that some dimensions of risk and impact can be measured, trends can be identified and that some nature-related opportunities can be estimated. When applied to the GPIF portfolios, we can spot a small number of industries that may represent more acute biodiversity risks through their operational processes, products or locations. These may evolve into financial risks, or even reputation risks, depending on local policy developments and consumer choices.

Analysis of climate-change-related risks

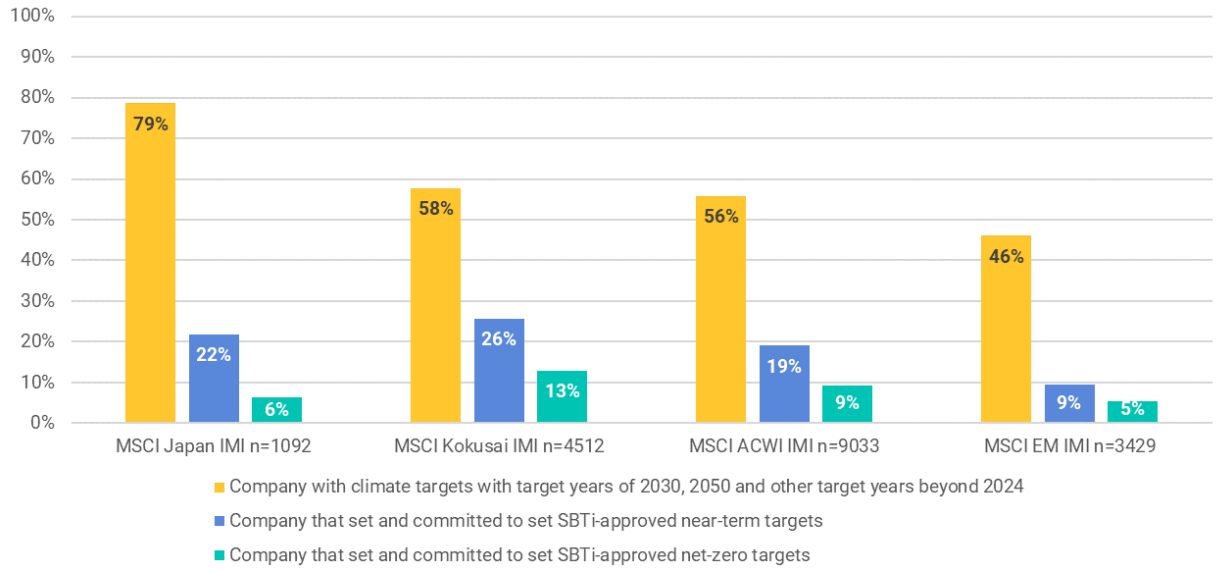
Status of companies' climate targets based on MSCI target-level data

The Paris Agreement has aimed to limit global average temperature rise to well below 2°C. It requires each signatory to communicate a nationally determined contribution (NDC) every five years.[3] This binding obligation on each nation was characterized as the ambition-raising cycle as it was intended to promote progressively stronger NDC over time. This was viewed as crucial by many states since the NDCs submitted to date were considered insufficient to meet the goal of the Paris Agreement.[4]

Globally, 145 nations covering approximately 90% of global greenhouse gas (GHG) emissions have adopted net-zero pledges, as of November 2023, and this is up from 88 nation states in 2022.[5] However, the NDCs, including these net-zero pledges, will not be achieved by state actors alone; the achievement will require the combined effort of governments and the public and private sectors. In the transition to a net-zero economy, companies could face regulatory risks centered on the emissions from their business activities, as stricter regulatory schemes such as carbon pricing would be introduced in more jurisdictions. Corporate climate targets can provide an indication of a company's intent to reduce its impact on climate change and minimize the potential risks associated with its emissions.

This section examines the status of corporate climate target setting.

Exhibit 1: Status of climate targets by constituent of the MSCI indexes



Source: MSCI ESG Research LLC., data as of Jun. 30, 2024.

Of the 9,033 companies in the MSCI ACWI Investable Market Index (IMI), an equity index comprised of large, mid and small cap constituents, 56% have set **ongoing climate targets beyond 2024**

[3] "The Paris Agreement, Art 14.2," United Nations Framework Convention on Climate Change, 2015.

[4] D. Bodansky, "International Climate Change Law," 2017.

[5] "CAT Net Zero Target Evaluations," Climate Action Tracker (CAT), accessed June 30, 2024.

(Exhibit 1). We also found that 19% of the issuers in the MSCI ACWI IMI have set or committed to setting decarbonization targets aligned with the standard defined by the SBTi [6] in near-term periods. The near-term targets indicated five to 10 years GHG mitigation targets, in line with the 1.5°C and 2°C goals of the Paris Agreement.[7]

Of the constituents in the MSCI ACWI IMI, 9% have set or committed to setting long-term targets, which would require companies to reduce their emissions to net-zero by 2050 while aligning with a 1.5°C pathway during the near term.[8] The United Nations' high-level expert group on net-zero commitments by the private sector recommended that investors have their targets verified by a third party, such as SBTi.[9]

Exhibit 1 also reflects our analysis of the status of corporate climate targets by market types, using constituents of three different indexes per region, namely Japan (the MSCI Japan Investable Market Index (IMI)), developed markets (the MSCI Kokusai Investable Market Index (IMI)[10]) and emerging markets (the MSCI Emerging Markets Investable Market Index (IMI)).

We found that 79% of companies in Japan and 58% of companies in developed markets, represented in the MSCI Japan IMI and MSCI Kokusai IMI, set some climate targets in 2024 (Exhibit 1). They have increased from 2023 by 14 and 6 percentage points, from 65% and 52%, respectively.[11] Higher rates of Japanese companies have set some climate targets, compared to other markets.

On the other hand, Japanese companies have lagged companies in the developed markets in terms of commitments to SBTi standards for near- and long-term periods. We have observed that 22% of the Japanese companies in the developed market have set SBTi-approved climate targets or committed to setting SBTi targets in the future, while 26% of the companies in the developed markets have made such commitments in 2024.[12] We note that the rates of companies in Japan and developed markets have also increased from 2023 by 4 and 2 percentage points, from 18% and 24%, respectively.

Of the 3,429 companies, 46%, 9% and 5% of companies in emerging markets represented by the MSCI Emerging Markets IMI have set some climate targets and committed to the SBTi near- and long-term targets in 2024.

These results indicate a trend: The developed countries had a higher percentage of companies setting decarbonization targets than those in the emerging markets. This could be attributed to capacity-building issues, regulatory pressures, common but differentiated responsibilities and respective capacities, in terms of shifting business models toward a low-carbon economy.

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[6] SBTi is an organization that help companies and investors to set climate targets aligned with the Paris Agreement. "SBTi Corporate Net-Zero Standard, Version 1.2," SBTi, March 2024.

[7] "SBTi Corporate Net-Zero Standard, Version 1.2," SBTi, March 2024.

[8] "SBTi Corporate Net-Zero Standard, Version 1.2," SBTi, March 2024. See Watanabe, K., "The Road to Science-Based Corporate Net-Zero Target Setting," MSCI ESG Research, Sept. 23, 2022.

[9] "Integrity Matters: Net Zero Commitments by Businesses, Financial Institutions, Cities and Regions," United Nations' High-Level Expert Group on the Net Zero Emissions Commitments of Non-State Entities, Nov. 8, 2022. See Watanabe, K et al., "Assessing Science-Based Corporate Climate Target-Setting," Jun. 9, 2023.

[10] The MSCI World Investable Market Index, excluding constituents in the MSCI Japan Investable Market Index.

[11] MSCI ESG Research LLC. "2023 Analysis of Climate Change-Related Risks in the GPIF's Portfolios." July 2023.

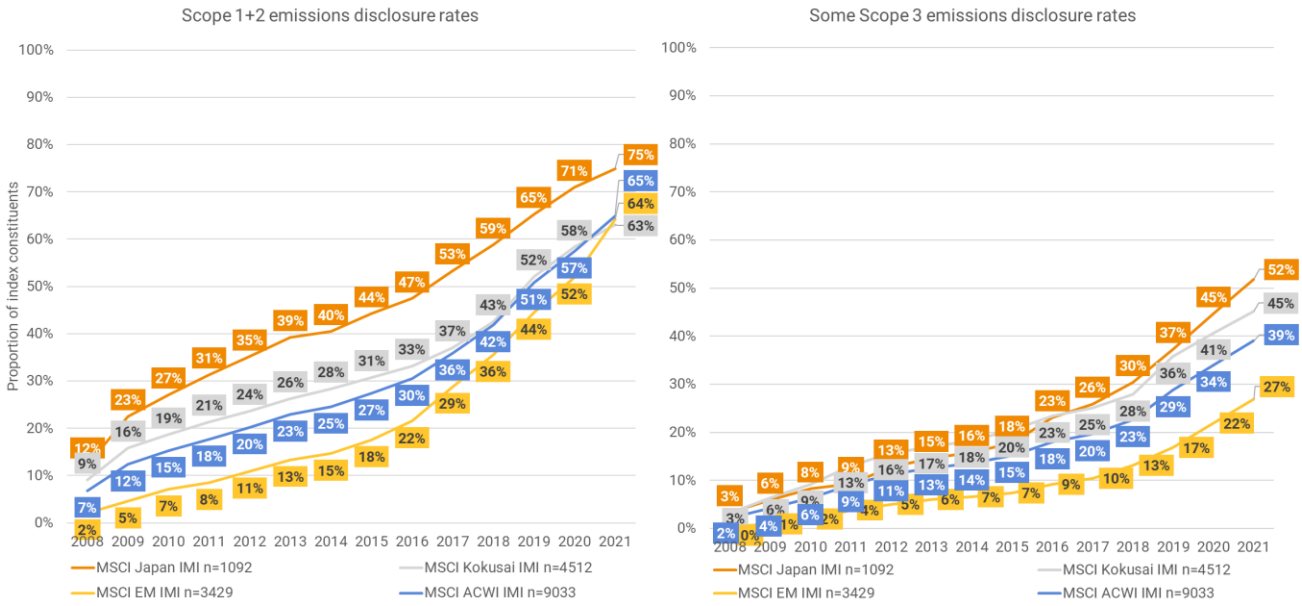
[12] "Company Taking Action," SBTi, accessed on Jun. 30, 2024.

Status of companies' scope 1 and 2 and some scope 3 emissions disclosure rates

For the first step of our corporate climate target assessments, we analyzed how many companies have reported emissions in line with the GHG Protocol[13] across the four different indexes — a fundamental first step to planning decarbonization strategies and measuring progress.

Of the 9,033 constituents in the MSCI ACWI IMI, 65% disclosed scope 1 and 2 emissions and 39% disclosed some scope 3 emissions, as of June 2024 (Exhibit 2). **Across the four indexes, companies in the MSCI Japan IMI showed the highest scope 1 and 2 disclosure rates, 75%.**

Exhibit 2: Status of scope 1, 2 and 3 emissions disclosure rates across the four MSCI indexes



Source: MSCI ESG Research, data as of Jun. 30, 2024.

Japanese companies have increased the disclosure rates of some scope 3 emissions by 7 percentage points to 52%, from 45% during 2020 and 2021, the highest increase rate across the four indexes. Companies in the MSCI Kokusai IMI have also increased the scope 1 and 2 disclosure rates by 5 percentage points to 63%, from 58% in the same time period.

These increases could be attributed to a series of corporate climate disclosure standards slated to take effect in the coming years, including aligning with the International Sustainability Standard Board's (ISSB's) mandatory disclosure of sustainability metrics for securities reports in Japan and the SEC's final rules in climate-related disclosure and corporate sustainability reporting standard in Europe.[14]

[13] Greenhouse Gas Protocol; https://ghgprotocol.org/corporate-standard

[14] "Financial Services Agency Working Group on Sustainability Information Disclosure and Assurance," Financial Service Agency, May 2024; "The Enhancement and Standardization of Climate-Related Disclosures for Investors," U.S. Securities and Exchange Commissions, March 2024; "Corporate Sustainability Reporting," European Commission, accessed Jun. 30, 2024. See World Resource Institute (WRI). May 6, 2024. "Corporate Climate Disclosure Has Passed a Tipping Point. Companies Need to Catch Up." Notes: the WRI estimated that once all pending disclosure rules are in force, they would cover nearly 40% of the world's economy. Also see Xiaoshu Wang, et al. May 2024. "APAC Climate Action Progress Report."

Of the 3,429 companies in the MSCI Emerging Markets IMI, 64% have disclosed scope 1 and 2 emissions, as of June 2024, rapidly catching up with the rest of the world. Nonetheless, the companies in the emerging markets have continued to lag the rest of the world in terms of scope 3 emissions reporting practices (27%).

Analysis of corporate GHG emissions and climate targets by scope

Using the MSCI's Target-Level Data, this section analyzed companies' emissions by scope and the rate of the companies' emissions that were covered by their targets ("comprehensiveness").[15]

In the transition to net-zero economies, a company may face regulatory risks centered on its operational emissions (i.e., scope 1 and 2). Its upstream suppliers (i.e., scope 3) may encounter increased costs for sourcing carbon intensive materials, and its downstream customers may show reduced demand for particular products based on their emissions, such as fossil fuels and conventional gasoline cars. For these reasons, setting targets that cover the most relevant scopes is important to understanding and managing potential regulatory and market risks.

Measuring the rates of emissions by scope and comparing those measurements to the emissions coverage rate of a company's stated target may help investors to assess the potential impact, as such targets could provide in mitigating transition risks in a low-carbon scenario.

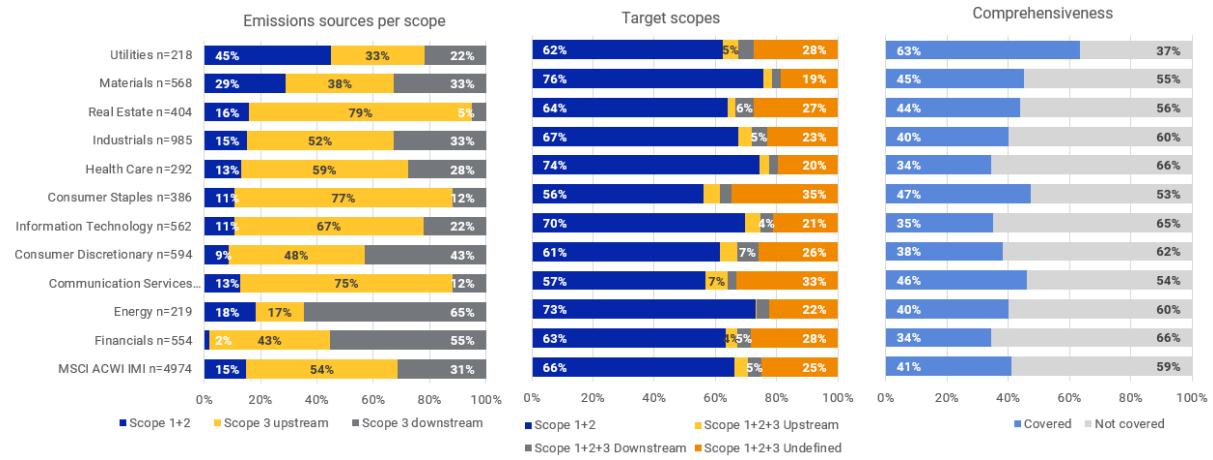
Exhibits 3, 4, 5 and 6 illustrate the aggregate of sector level emissions by scope, compared to the scope of company targets. They also demonstrate the misalignment between the most carbon-intensive aspects of companies' business activities and the scopes their targets cover.

Across the four indexes, most targets set by the utilities and materials sectors focused on their own operations, the highest-emitting business activities (i.e., scope 1 and 2), indicating some of the highest coverage ratios by their targets. However, we found greater degrees of misalignment in other sectors. When large misalignments occur, it could imply that certain climate risks are not being disclosed or appropriately considered, which elevates the uncertainty around whether transition risks are being managed adequately.

Scope 3 emissions represent the largest gap because they have typically been beyond traditional target-setting practices. Scope 3 risks involve clients and suppliers, so they can often reside beyond the control or risk management practices of the company. We have observed that the companies in the developed markets represented by the MSCI Kokusai IMI showed the highest proportions of the companies setting scope 3 targets at 44%, compared to 34%, 26% and 20% of the MSCI ACWI IMI, MSCI Japan IMI and MSCI Emerging Markets IMI, respectively.

[15] Based on the MSCI Climate Target and Commitments Dataset. Climate Target and Commitments Dataset - MSCI

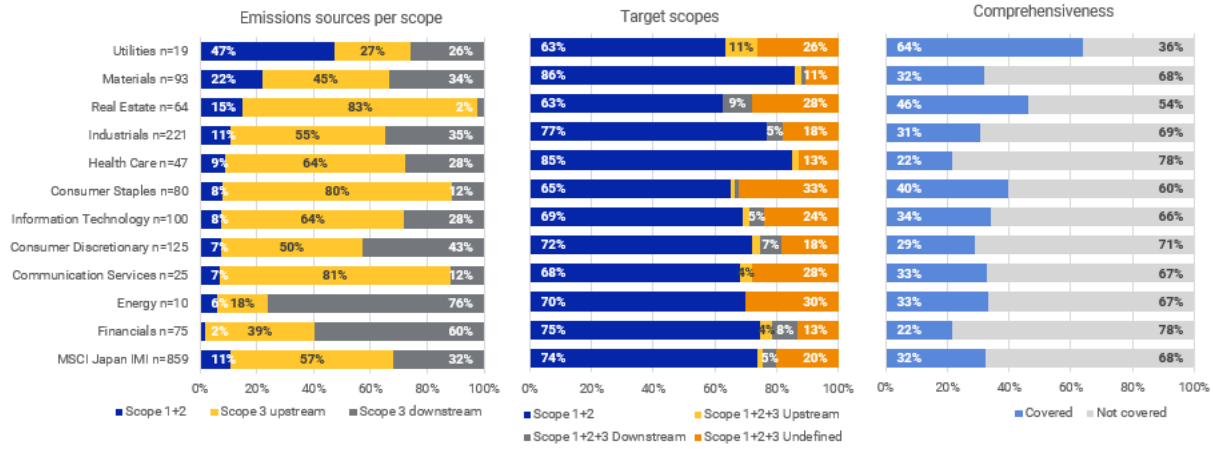
Exhibit 3: GHG emissions and reduction targets by companies in the MSCI ACWI IMI



Source: MSCI ESG Research, data as of Jun. 30, 2024.

Note: The chart on the left indicates average percentages of emissions from scope 1 and 2 boundaries and scope 3 upstream and downstream boundaries. The chart in the center indicates percentages of companies in their final target year aiming at reducing scope 1 and 2 emissions, scope 1, 2 and 3 upstream and downstream emission and scope 1 and 2 and undefined categories of scope 3 emissions. The chart on the right indicates the average percentages of total emissions covered by targets in each sector of the Global Industry Classification Standard (GICS®).[16]

Exhibit 4: GHG emissions and reduction targets by companies in the MSCI Japan IMI

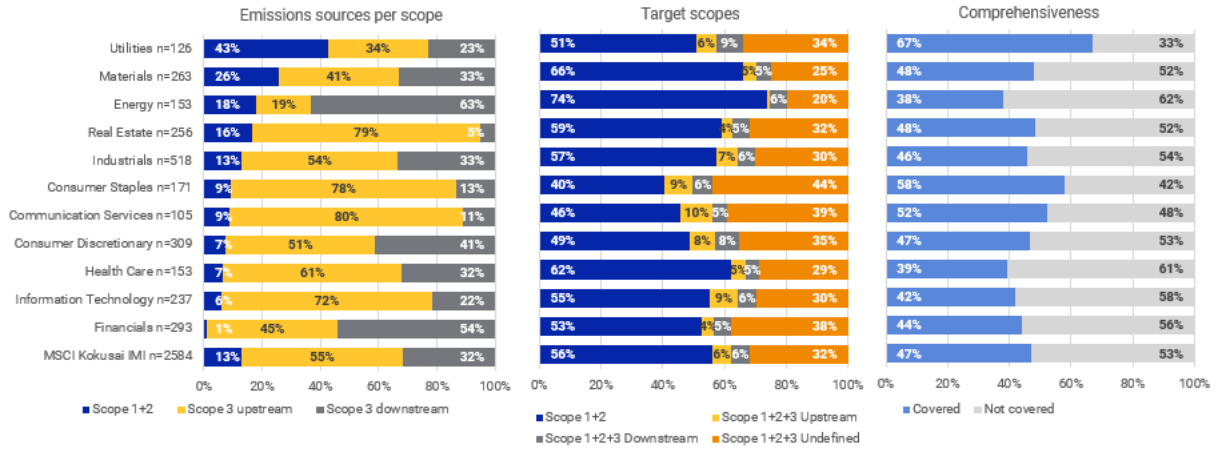


Source: MSCI ESG Research, data as of Jun. 30, 2024.

Notes: The chart on the left indicates the average percentages of emissions from scope 1 and 2 boundaries and scope 3 upstream and downstream boundaries. The chart in the center indicates the percentages of companies in their final target year aiming to reduce scope 1 and 2 emissions, scope 1, 2 and 3 upstream and downstream emission and scope 1 and 2 and undefined categories of scope 3 emissions. The chart on the right indicates the average percentages of total emissions covered by targets in each GICS sector.

[16] GICS is the global industry classification standard jointly developed by MSCI and S&P Global Market Intelligence.

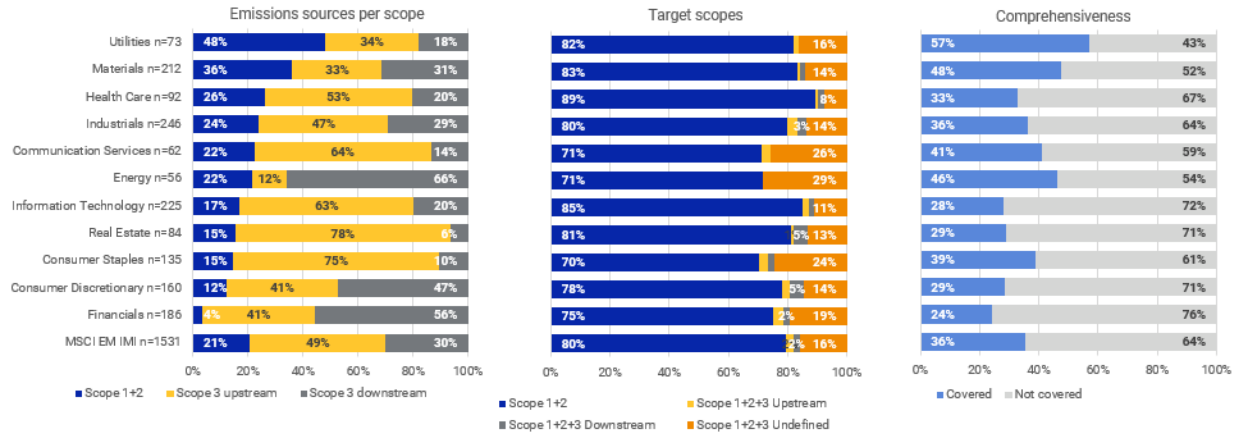
Exhibit 5: GHG emissions and reduction targets by companies in the MSCI Kokusai IMI



Source: MSCI ESG Research, data as of Jun. 30, 2024.

Notes: The chart on the left indicates the average percentages of emissions from scope 1 and 2 boundaries and scope 3 upstream and downstream boundaries. The chart in the center indicates the percentages of companies in their final target year aiming to reduce scope 1 and 2 emissions, scope 1, 2 and 3 upstream and downstream emission and scope 1 and 2 and undefined categories of scope 3 emissions. The chart on the right indicates the average percentages of total emissions covered by targets in each GICS sector.

Exhibit 6: GHG emissions and reduction targets by companies in the MSCI Emerging Markets IMI



Source: MSCI ESG Research, data as of Jun. 30, 2024.

Notes: The chart on the left indicates the average percentages of emissions from scope 1 and 2 boundaries and scope 3 upstream and downstream boundaries. The chart in the center indicates the percentages of companies in their final target year aiming to reduce scope 1 and 2 emissions, scope 1, 2 and 3 upstream and downstream emissions and scope 1 and 2 and undefined categories of scope 3 emissions. The chart on the right indicates the average percentages of total emissions covered by targets in each GICS sector.

Meanwhile, upstream and downstream supply chain emissions constitute, by far, the largest portion of the carbon footprint across all four indexes (the average percentage of emissions from upstream and downstream supply chains was; 85% for the MSCI ACWI IMI, 89% for the MSCI Japan IMI, 87% for the MSCI Kokusai IMI, and 79% for the MSCI Emerging Markets IMI). As operational and market

risks associated with scope 3 emissions start impacting businesses (e.g., through regulations such as Carbon Boarder Adjustment Mechanism (CBAM) as well as through reduced demands for carbon intensive products and services), we may see more scope 3 emissions targets across the indexes.

During 2023 and 2024, we have observed that the companies in the developed markets represented by the MSCI Kokusai IMI increased the proportion of companies setting scope 3 targets by 6 percentage points, to 44% from 38%; MSCI ACWI IMI increased the proportion by 3 percentage points, to 34% from 31%; MSCI Japan IMI by 2 percentage points, to 26% from 24%; and MSCI Emerging Markets IMI remained the same at 20%, but the proportion of companies setting Scope 3 downstream targets increased to 2% of the index constituents.

Companies that set scope 3 targets may demonstrate a broader climate risk awareness and strategy than peers that do not, potentially further reducing transitional risks tied to their products and supply chains.

Our analysis of our target-level data showed that the comprehensiveness, or emissions coverage rate, of companies' climate targets depends greatly on the status of their scope 3 target setting. As more progress is made in scope 3 emissions disclosures and target setting, the emissions scopes covered by targets could become more aligned with the boundaries of their GHG emissions.

During 2023 and 2024, we have observed the companies in the MSCI Kokusai IMI increase the proportions of their value chain covered by the targets, which increased by 13 percentage points, to 47% from 34%; MSCI ACWI IMI increased by 9 percentage points, to 41% from 32%; MSCI Japan IMI by 8 percentage points, to 32% from 24%; and MSCI Emerging Markets IMI by 6 percentage point to 36% from 30%.

Analysis of corporate climate target credibility

Although an increasing number of companies are setting climate targets, the likelihood of these targets being met will vary. Using several key indicators recommended by the Glasgow Financial Alliance for Net-Zero (GFANZ),[17] we have built our own target credibility weighting system to help investors assess whether companies have taken the steps necessary to achieve their targets.[18]

The current target credibility weighting system is composed of the following four indicators:

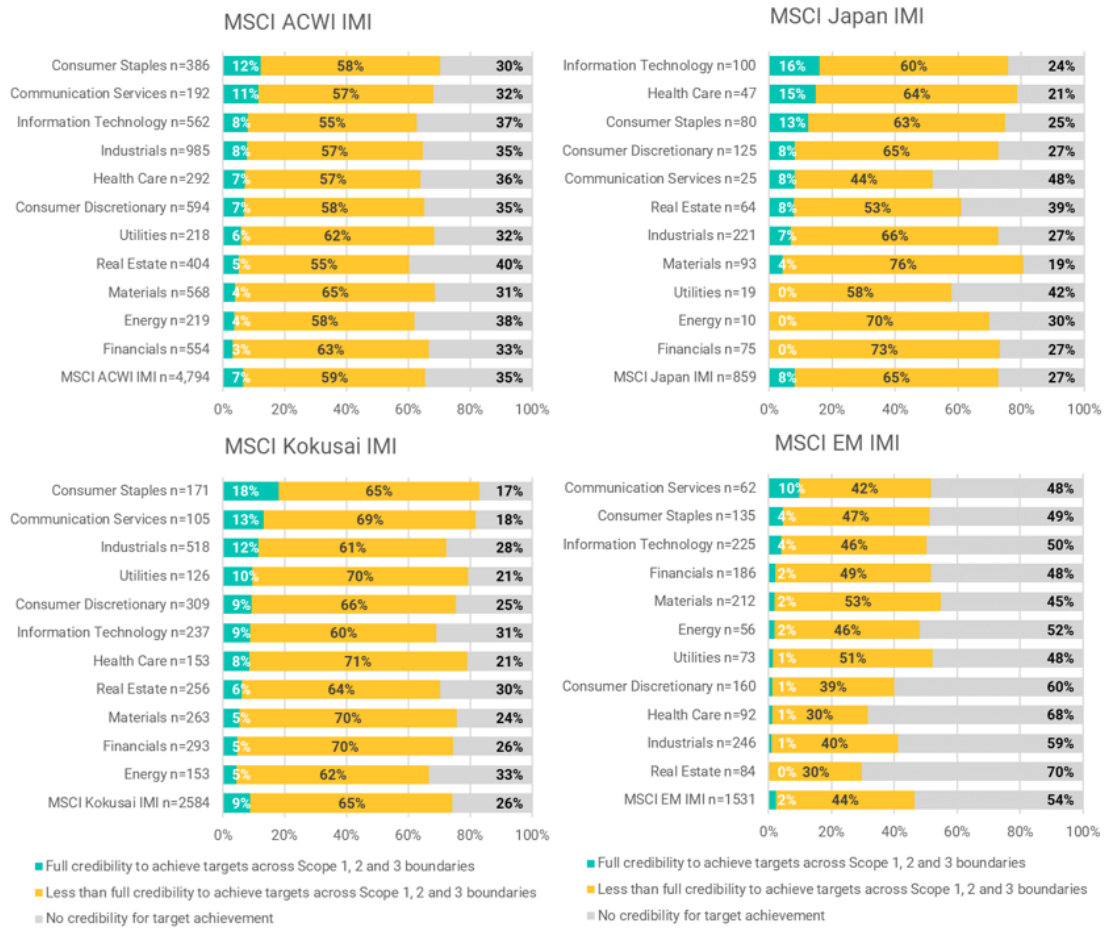
- At least one short-term target for the relevant scope (e.g., scope 1 absolute emissions reduction by 30% below 2020 levels by 2030)
- At least one externally validated target (e.g., SBTi standard)
- A track record of achieving past targets
- A current trajectory to meet at least some ongoing targets

The majority of the companies in the four indexes, did not have fully credible targets across scope 1, 2 and 3 boundaries (Exhibit 7).

[17] "Measuring Portfolio Alignment: Driving Enhancement, Convergence, and Adoption," GFANZ, November 2022.

[18] For detailed methodology, see MSCI ESG Research, "Implied Temperature Rise Methodology," February 2024.

Exhibit 7: Target credibility assessments across the MSCI indexes



Source: MSCI ESG Research, data as of Jun. 30, 2024.

The disparities in data availability and quality for emissions disclosure and target-setting practices underline the different starting points and market nuances across the indexes. With the ongoing rollout of mandatory emissions disclosure and target-setting standards, these differences may be reduced over time, helping companies report more consistent, comparable and credible emissions data, target-setting and transition plans, which may support climate-informed capital allocation decisions.[19]

Impact analysis using ITR

MSCI's ITR computes the forward-looking temperature alignment of companies, portfolios and funds with global temperature goals. ITR helps investors drive decarbonization in the real world by evaluating how companies and portfolios manage their "fair share" of decarbonization efforts to limit global warming.

To do so, ITR allocates a carbon budget to companies that can be aggregated at portfolio level. The model then extrapolates the global ITR at a 2100 horizon as if the global economy had the same carbon budget overshoot or undershoot as a given company or portfolio. For instance, an ITR in excess of 2°C signals that company climate targets are not ambitious enough to be compatible with a 2°C world. New company targets are dynamically integrated in the ITR, which helps investors set portfolio temperature objectives and their engagement with financed companies.

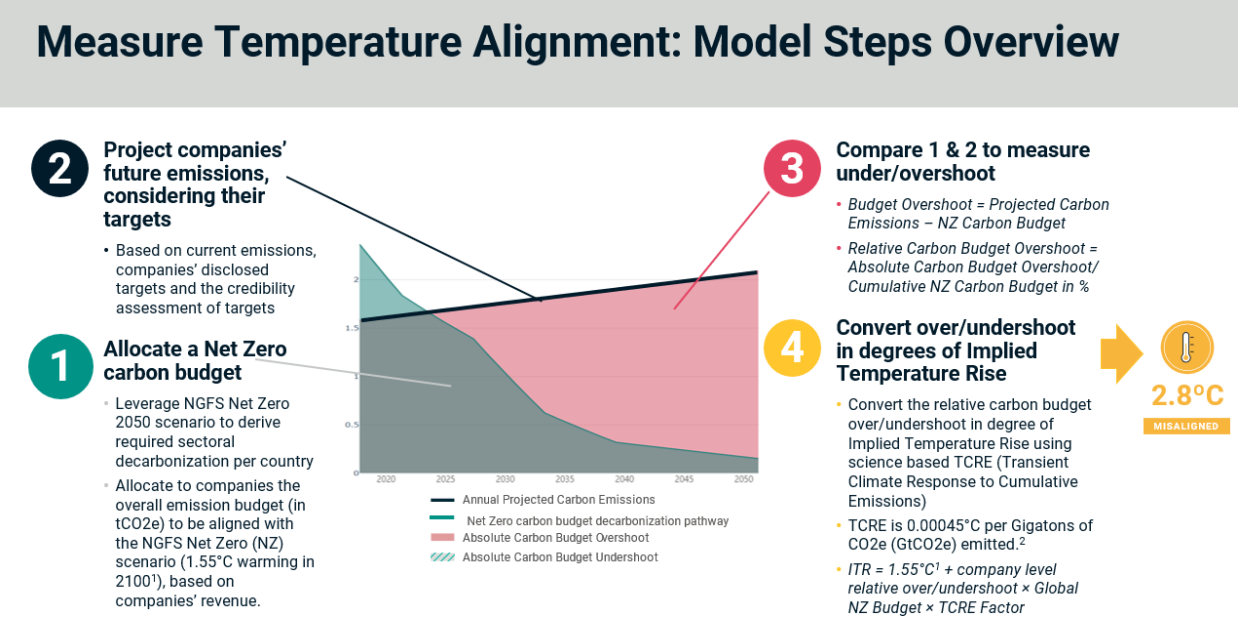
The ITR model can compare corporate climate targets at face value (assuming they will be fully followed through and achieved) and those with target credibility assessments. Using guidance from the GFANZ Portfolio Alignment recommendations, MSCI ESG Research has developed a target credibility assessment whereby climate targets can be discounted to some extent by a credibility weight.[20]
ITR is also well suited to disclose the alignment of financial activities with a scenario well below 2°C, as recommended by the Task Force on Climate-related Financial Disclosures (TCFD).[21]

[19] See Wang, Xiaoshu et al., "APAC Climate Action Progress Report," May 28, 2024.

[20] GFANZ, "Measuring Portfolio Alignment: Driving Enhancement, Convergence, and Adoption," November 2022.

[21] TCFD, "Guidance on Metrics, Targets, and Transition Plans," October 2021. That is the key focus of this report. See full methodology guide on www.msci.com/our-solutions/climate-investing/implied-temperature-rise.

Exhibit 8: Model steps overview for ITR



Source: MSCI ESG Research.

MSCI ESG Research implemented a few updates to the ITR methodology since the publication of the last year's report:[22]

- **Integrated oil and gas companies are assessed against a single scope 3 pathway reflecting the average emissions intensity across the various oil and gas activities of the sector.** This replaces a previous approach where different pathways were used depending on the specific oil and gas activities of these companies (e.g., petroleum refining). From an output standpoint, such features will warm the ITR of integrated oil and gas companies engaged in relatively less carbon intensive activities.
- **The scope 3 category 15 (investment emissions of companies) are specifically benchmarked against two types of pathways:** a loan book pathway reflecting the average loan book emissions intensity per dollar lent across the MSCI ACWI IMI and an Asset Under Management (AUM) pathway reflecting the average AUM intensity per dollar invested across the MSCI ACWI IMI. This adjustment particularly affects financial companies and replaces a previous approach in which all of company scope 3 emissions, including category 15, were benchmarked against a broad pathway reflecting the average scope 3 revenue intensity for the relevant sector. As a result, ITR budgets and outputs are expected to be more proportionate to the lending and investing activities of companies.

Because of the model updates, we note that comparison with ITR data previously reported by GPIF has some limits.

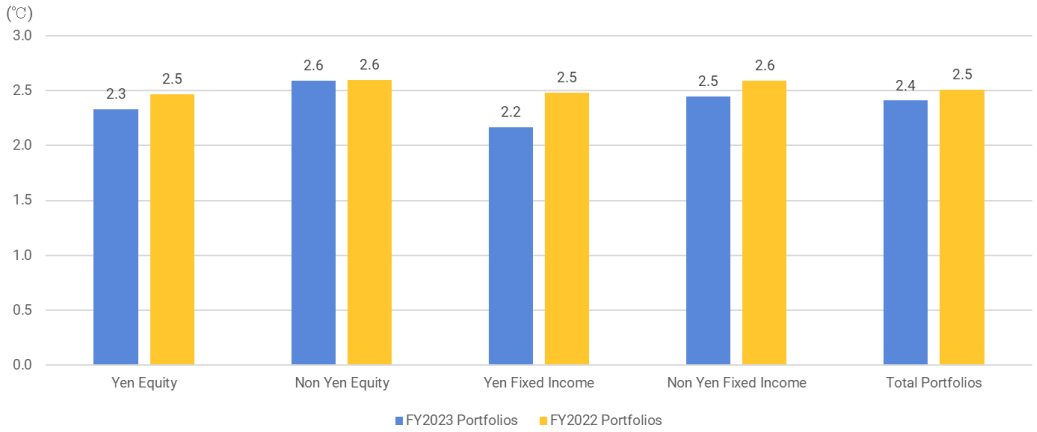
This report section analyzes the following elements:

- Comparison of the GPIF's total portfolio ITRs between FY2022 (as of the end of March 2023) and FY2023 (as of the end of March 2024)

[22] MSCI ESG Research LLC. "2023 Analysis of Climate Change-Related Risks in the GPIF's Portfolios," July 2023.

- Asset class level ITRs within the FY2023 total GPIF portfolio
- GICS sector level ITRs for each of the four asset classes (yen equity, non-yen equity, yen fixed income, and non-yen fixed income) in FY2023 and FY2022 GPIF portfolios

Exhibit 9: ITR results per asset class: FY2023 and FY2022



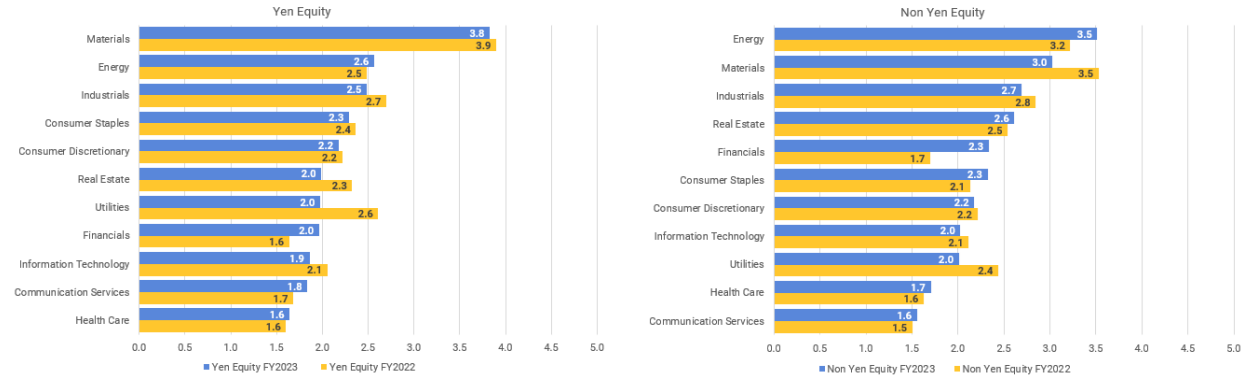
Source: MSCI ESG Research, Jun. 30, 2024.

The chart above shows that, aside from the yen equity and yen fixed income portfolios, the model updates do not significantly impact broad asset class or regional aggregated outputs even though individual sectors or issuers, such as those in energy and financial sectors that went through model enhancement during April 2023 and June 2024, may be more impacted.

We also performed this comparative analysis of ITR across GICS sectors, both for GPIF's yen and non-yen equity portfolios in FY2022 and FY2023. Both the yen and non-yen portfolios showed systematically lower ITR values when targets are taken into consideration in every sector. Sectors such as the financial sector showed increases in ITR values for yen equity and non-yen equity in FY2023 from FY2022, which might be due in part to the model enhancements described above. Many other sectors showed a decreased ITR during FY2022 and FY2023. This indicates that a larger number of companies in these sectors set more ambitious targets in FY2023 than they did in FY2022. While the fact that growing number of companies set climate targets is a positive trend, achieving targets is the next important step and also a more demanding prospect than setting them.[23] Thus, monitoring emission reduction progress will be important to determine whether companies' commitments are realistic in those sectors. We see similar results when doing the same analysis on yen and non-yen fixed income portfolios.

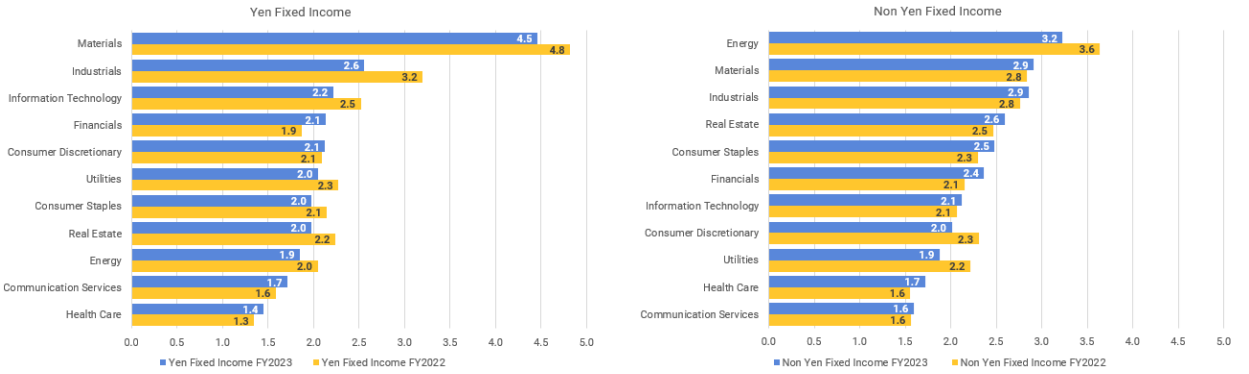
[23] See Watanabe, K. et al., "Assessing Science-Based Corporate Climate Target-Setting," Jun. 9, 2023.

Exhibit 10: Difference in ITR (°C) between FY2022 and FY2023 yen and non-yen equities portfolios



Source: MSCI ESG Research, Jun. 30, 2024.

Exhibit 11: Difference in ITR (°C) between FY2022 and FY2023 yen and non-yen fixed Income portfolios



Source: MSCI ESG Research, Jun. 30, 2024.

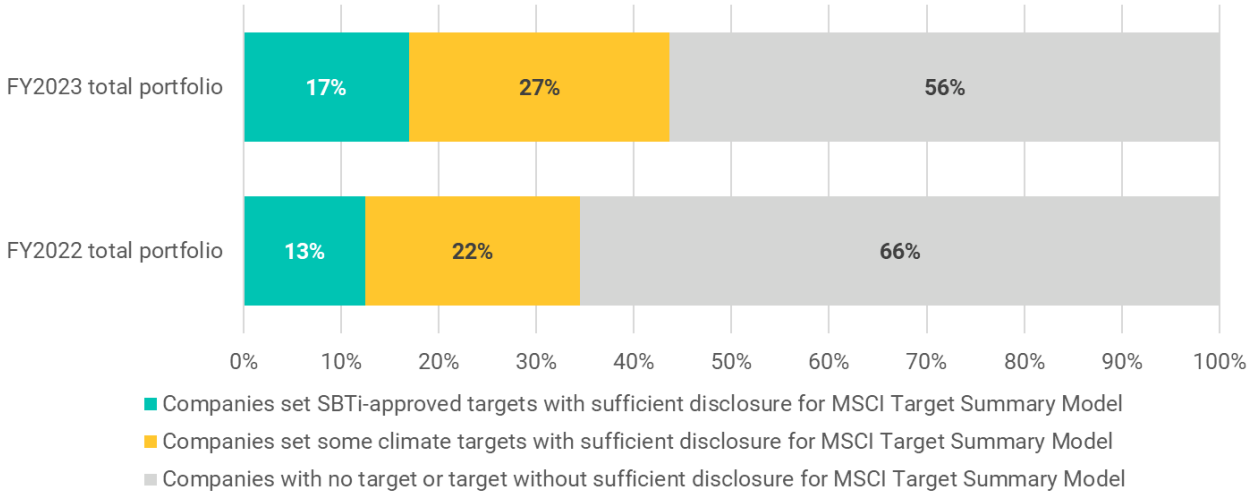
Climate targets are a key input for the ITR model, which can also be analyzed on a standalone basis. The share of issuers with various type of climate-related targets shows the extent to which GPIF invests in businesses committed to climate actions.

The companies that have not set a target or have set targets with insufficient details[24] have decreased from 66% in FY2022 to 56% in FY2023. The proportion of the companies with sufficient target-level data disclosure has also increased by 9 percentage points, to 44% (i.e., 17% of companies with SBTi-approved targets and 27% with some targets) in FY2023 from 35% (i.e., 13% of companies with SBTi-approved targets and 22% with some targets) in FY2022.

[24] Under the MSCI Target Summary Model, sufficiently granular target-level data, i.e., the following data points are required for emissions projections and progress of emissions reduction: target type (e.g., absolute or intensity target. If intensity, intensity type), targeted scopes and categories, emissions reduction percentages, base year and base year emissions, targeted year and targeted year emissions, reported year and reported year emissions, and coverage ratios of targeted scopes and categories.

The SBTi assesses and validates corporate climate targets that would reduce their emissions aligning with the Paris Agreement goals over the near- and long-terms.

Exhibit 12: Changes in the proportions of issuers with SBTi-approved targets, detailed climate targets and no clear target in the total portfolios in FY2022 and FY2023

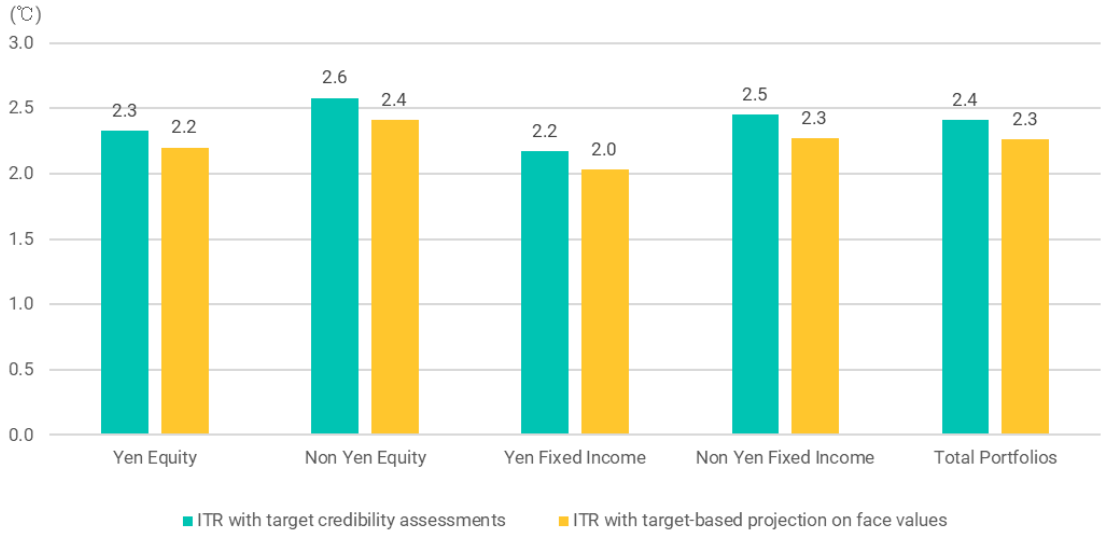


Note: Please refer to the footnote 24 regarding sufficient disclosure for the MSCI Target Summary Model. Source: MSCI ESG Research, Jun. 30, 2024.

The target credibility assessment applies to all three GHG emissions scopes. It takes into account the existence of short-term targets, third-party verification (typically undertaken by SBTi), the company's track record for achieving past targets, and progress toward current targets.[25] As expected and evidenced in the following exhibit, since some targets are discounted, the ITR reflecting target credibility assessment produces "warmer" values across GPIF's invested asset classes when compared to the same model without the target credibility assessment feature.

[25] For details, see MSCI ESG Research LLC. "2023 Analysis of Climate Change-Related Risks in the GPIF's Portfolios." July 2023.

Exhibit 13: Comparative analysis of ITRs between targets at face value vis–à–vis target credibility assessments for FY2023 portfolio



Source: MSCI ESG Research, Jun. 15, 2024.

In summary:

- ITR value in the GPIF total portfolios slightly improved to 2.4°C in FY2023 from 2.5°C in FY2022. This reflects the fact that more companies in the portfolios have set climate targets, including SBTi-approved targets during the same period. This is a positive change toward a "cooler" portfolio ITR assessment.
- When compared to a broad benchmark (the MSCI ACWI IMI, standing at 2.6°C as of June 2024), we found that the GPIF's total portfolios displayed a slightly better ITR of 2.4°C. Even though GPIF may be considered a "universal owner" whose investments are broadly comparable to the world's global economy, its portfolio ITR is more aligned with the goals of the Paris Agreement than the MSCI ACWI IMI, the broad investment universe in which GPIF operates.
- When taking corporate targets at face value, the GPIF ITR values would improve by 0.1°C to 2.3°C (taking target at face value) from 2.4°C (target credibility assessments). Indeed, the target credibility assessment, which discounts some targets-based emissions projections, makes ITR values warmer by adjusting companies' projected emissions based on target credibility weights (Exhibit 13).

Climate-change-related risks for portfolios

We used MSCI Climate VaR[26] to conduct analysis of climate-change-related risks for the GPIF's portfolios. Climate VaR provides a forward-looking and returns-based valuation assessment to measure climate-related risks and opportunities in an investment portfolio. Climate VaR provides a stressed market valuation of a security in relation to aggregated transition, physical climate-related cost and profit projections until the end of the century. The aggregated company Climate VaR is calculated as a percentage of market value for a given climate scenario.

For each scenario, the aggregated Climate VaR calculates valuation impacts of an issuer arising from climate transition risks and opportunities and physical climate risks.

Transition risks and opportunities: The policy scenarios aggregate potential future policy costs. By overlaying climate policy outlooks and future emission reduction cost estimates onto company data, MSCI ESG Research's model provides insights into how current and forthcoming climate policies may affect companies. The model integrates policy risks from electricity use (scope 2) and from value chain GHG emissions (scope 3) alongside policy risk from direct GHG emissions (scope 1). The technology scenarios identify current green revenues and the low-carbon patents held by companies, calculate the relative quality score of each patent[27] over time and forecast green revenues and profits of corporations based on their low-carbon innovative capacities.[28]

Physical risks and opportunities: The physical scenarios evaluate the impact and financial risk relating to a set of extreme weather hazards, including extreme heat and cold, heavy snowfall and precipitation, wind gusts, tropical cyclones and coastal flooding.[29]

Financial impact modeling: MSCI ESG Research translates climate-related costs into valuation impacts on a company-level in aggregate and its publicly tradable securities.

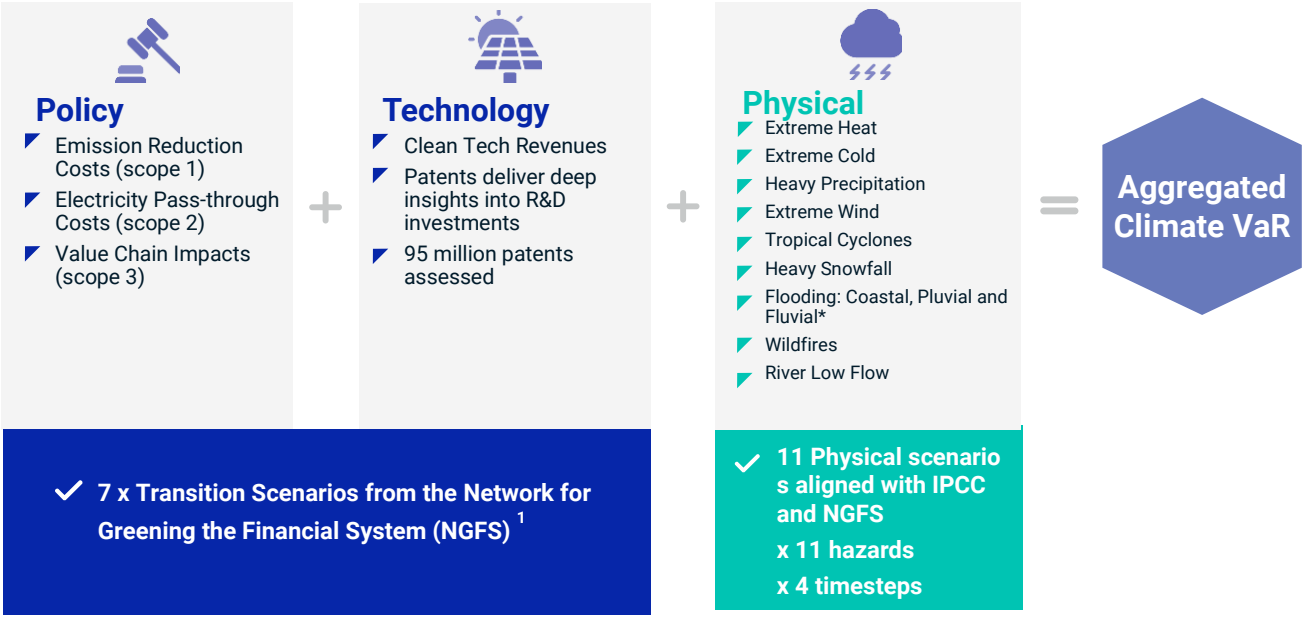
[26] For details about the MSCI Climate VaR, please see Scenario Analysis - MSCI

[27] MSCI ESG Research's Low-Carbon Patent Score seeks to establish a picture of the relative level and quality of patents held by companies. Each patent receives a score based on forward citations, backward citations, market coverage and Cooperative Patent Classification (CPC)/International Patent Classification (IPC) coverage. MSCI ESG Research's model covers 95 million unique patents that have been granted from more than 70 patent authorities worldwide as of April 2020.

[28] For the analysis in this report, we used a new "high upside" technology opportunities factor, which was released in May 2024, that explores alternative, less conservative assumptions on profit margins and future low-carbon revenue pools. For details, please see "Climate Value-at-Risk and Temperature Alignment: Model Update Notes." MSCI ESG Research, May 2024. (Client access only.)

[29] For the analysis in this report, we used an average scenario. MSCI ESG Research uses a probabilistic modelling framework to determine the distribution of the annual cost from weather extremes for assets at a given location. This approach allows us to determine the average cost from climate change while exploring the possibility of more severe outcomes. By default, we calculate the average scenario by considering the expected value of the cost distribution. The corresponding aggressive scenario is derived from the 95th percentile of the cost distribution and explores the severe downside risk within the distribution tail.

Exhibit 14: Overview of Climate VaR



[1] NGFS, "NGFS Scenarios for Central Banks and Supervisors," November 2023.

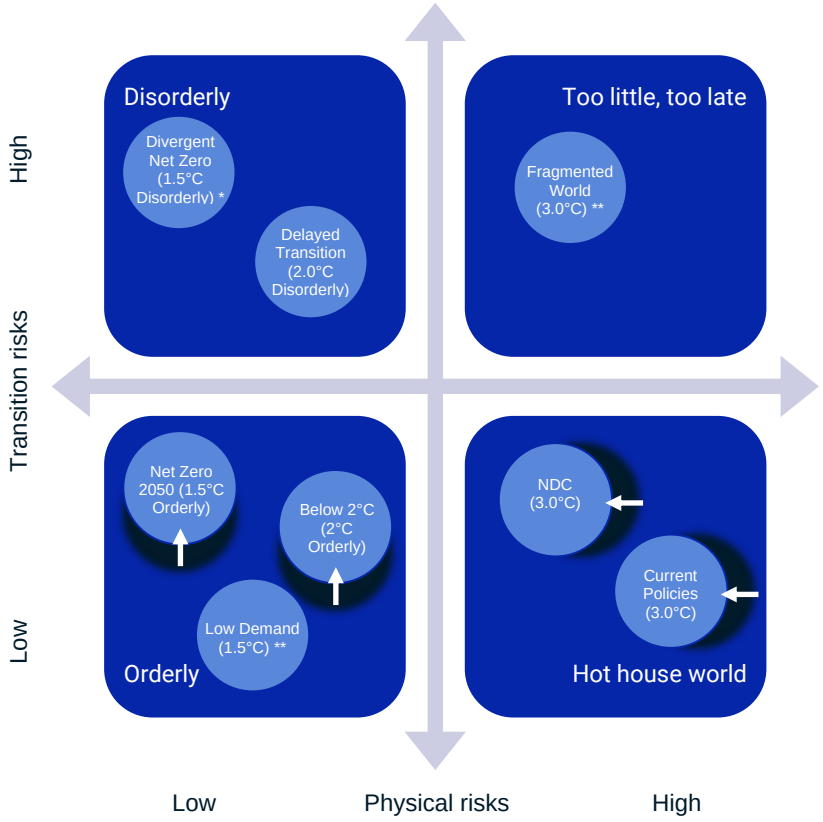
While NGFS provides seven transition scenarios from phase 4, MSCI currently provides eight scenarios, in total, by providing the Divergent Net-Zero scenario in addition to the seven scenarios under phase 4. While NGFS has made the decision to remove the Divergent Net-Zero from phase 4 due to the NGFS seeing a reduced likelihood of a successful uncoordinated transition and thus a reduced usability of the scenario, we will continue to offer this scenario until further notice, but it will continue to function on phase 3 data.[30]

* Pluvial flooding available as of mid-2024 but was not included in the analysis of this report.

Source: MSCI ESG Research.

[30] MSCI ESG Research, "NGFS Phase 4 Scenario Update — Corporate Climate VaR Model Results," March 2024. (Client access only.)

Exhibit 15: NGFS scenarios framework (from phase 3 to phase 4)



Quadrant	Scenario	Physical risk***	Transition risk			
			Policy reaction	Technology change	Carbon dioxide removal	Regional policy variation
Orderly	Low Demand**	1.4°C	Immediate and smooth	Fast change	Medium use	Medium variation
	Net Zero 2050	1.4°C	Immediate and smooth	Fast change	Medium-high use	Medium variation
	Below 2°C	1.7°C	Immediate and smooth	Moderate change	Medium use	Low variation
Disorderly	Divergent Net Zero*	1.4°C	Immediate but divergent across sectors	Fast change	Low-medium use	Medium variation
	Delayed Transition	1.7°C	Delayed	Slow/Fast change	Medium use	High variation
Hot house world	NDC	2.4°C	NDCs	Slow change	Low use	Medium variation
	Current Policies	2.9°C	None-current policies	Slow change	Low use	Low variation
Too little-too-late	Fragmented World**	2.3°C	Delayed and fragmented	Slow/Fragmented change	Low-medium use	High variation

*Note: White arrow indicates direction of change from phase 3. *Excluded from phase 4. **Newly added from phase 4. *** Policy ambition for Divergent Net Zero and end of century warming (model average) for the other scenarios.*
Source: MSCI ESG Research; NGFS, "NGFS Scenarios for Central Banks and Supervisors," November 2023.

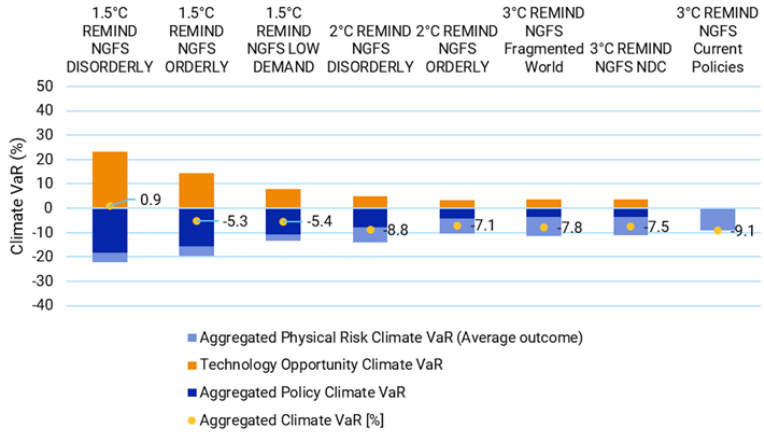
NGFS, "NGFS Climate Scenarios Technical Documentation V4.2," November 2023. NGFS, "NGFS Scenarios for Central Banks and Supervisors," September 2022

Analysis of equity and corporate bond portfolio

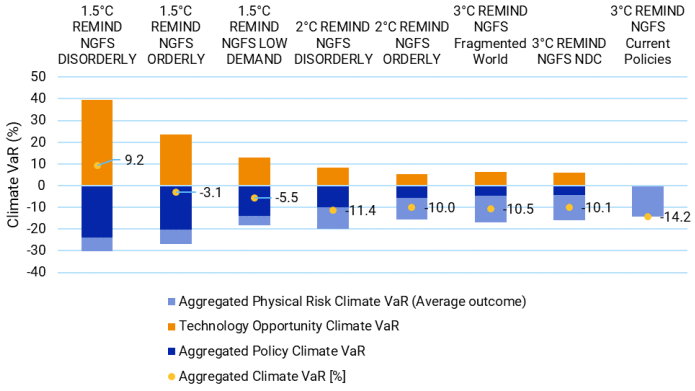
GPIF's total portfolio including domestic and foreign equity and corporate bond had the largest positive Climate VaR under the 1.5°C Disorderly (Divergent Net-Zero) scenario due to relatively high technology opportunities offsetting relatively high policy risks (Exhibit 16). On the other hand, it had the largest negative Climate VaR under 3°C Current Policies scenario due to relatively high physical risk. We assume there is no transition risk under 3°C Current Policies scenario. Among four asset classes in the GPIF's portfolios, domestic equity portfolio showed the largest technology opportunity Climate VaR, especially under 1.5°C scenarios. Under higher temperature scenarios, however, domestic equity portfolio had relatively large negative physical risk Climate VaR.

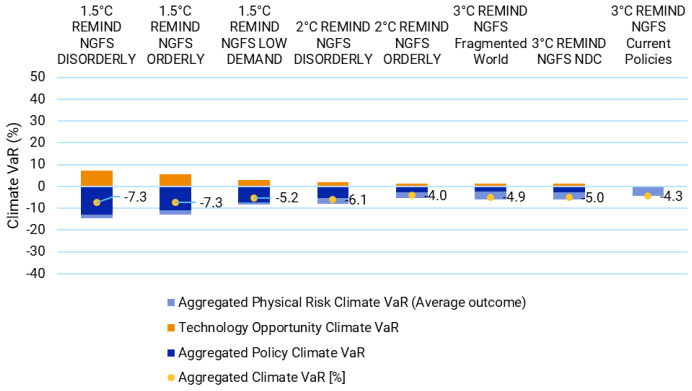
Exhibit 16: Climate VaR results for FY2023 portfolios

Total Portfolio

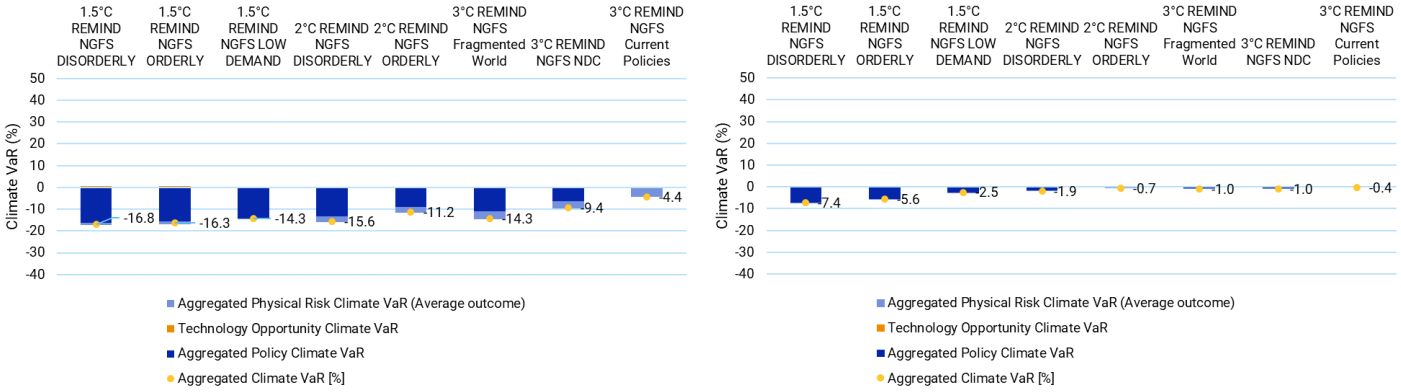


Equity portfolio: Domestic equity (left), foreign equity (right)





Corporate bond portfolio: Domestic corporate bond (left), foreign corporate bond (right)

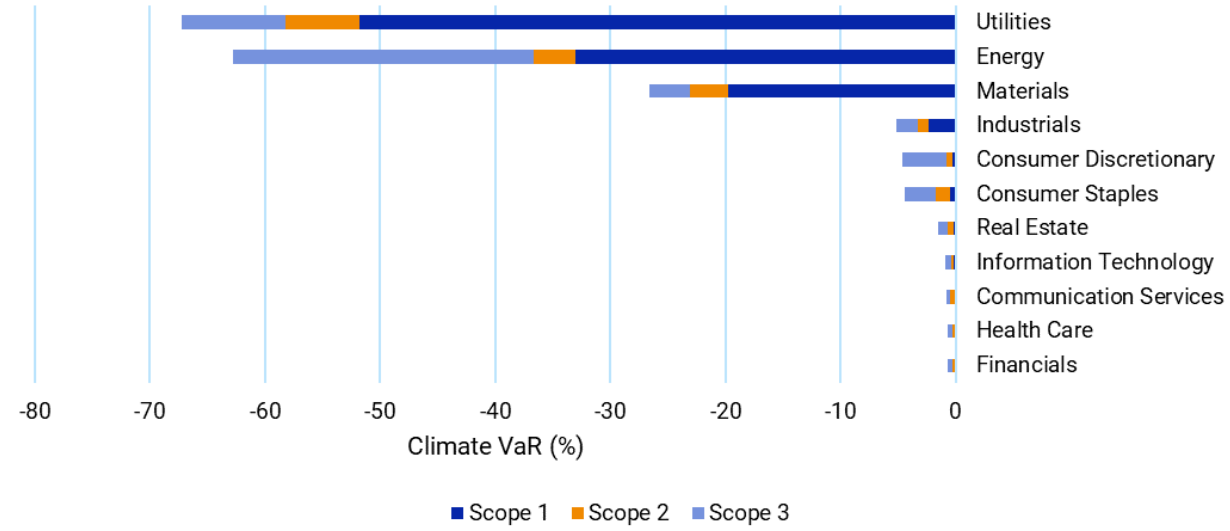


Source: MSCI ESG Research, as of June 2024.

We took a deeper look at each component of Climate VaR for domestic equity portfolio under 2°C Orderly as an example. Policy risk Climate VaR can be broken down into scope 1, 2 and 3. Utilities, energy and materials sectors had among the largest policy risk Climate VaR (Exhibit 17). Scope 1 contributed the most in utilities and materials sectors, which is in line with the fact that scope 1 emissions accounted for a relatively large portion of emissions per scope for those two sectors for the MSCI Japan IMI portfolio. Energy sector, on the other hand, had significant policy risk from scope 3 (value chain) and scope 1, which is again in line with the analysis in the previous section (Exhibit 4) that scope 3 emissions accounted for the largest portion in emissions per scope.

Exhibit 17: Policy risk Climate VaR for FY2023 domestic equity portfolio per scope per sector

(NGFS 2°C Orderly)



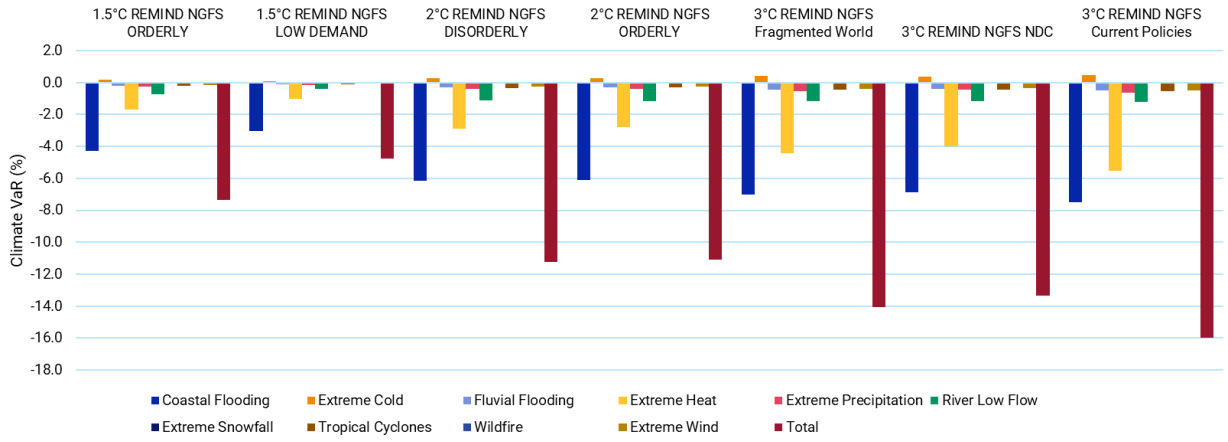
Source: MSCI ESG Research, as of June 2024.

For physical risk Climate VaR, coastal flooding and extreme heat showed relatively large risks among hazard types (Exhibit 18). We reflect regional characteristics when assessing frequency and severity of extreme weather caused by climate change. So, it is possible that weather conditions

such as high temperatures and high humidity during the summer in Japan heighten the risks related to extreme heat and its being an island surrounded by the sea heighten the risks related to coastal flooding.

Among sectors, utilities showed the largest risk (Exhibit 19). Utilities companies that have a power plant on the coast can have high risks related to coastal flooding. So a situation in Japan where many power plants are located on the coast could be one of the reasons why utilities sector in domestic equity portfolio have high risks related to coastal flooding.

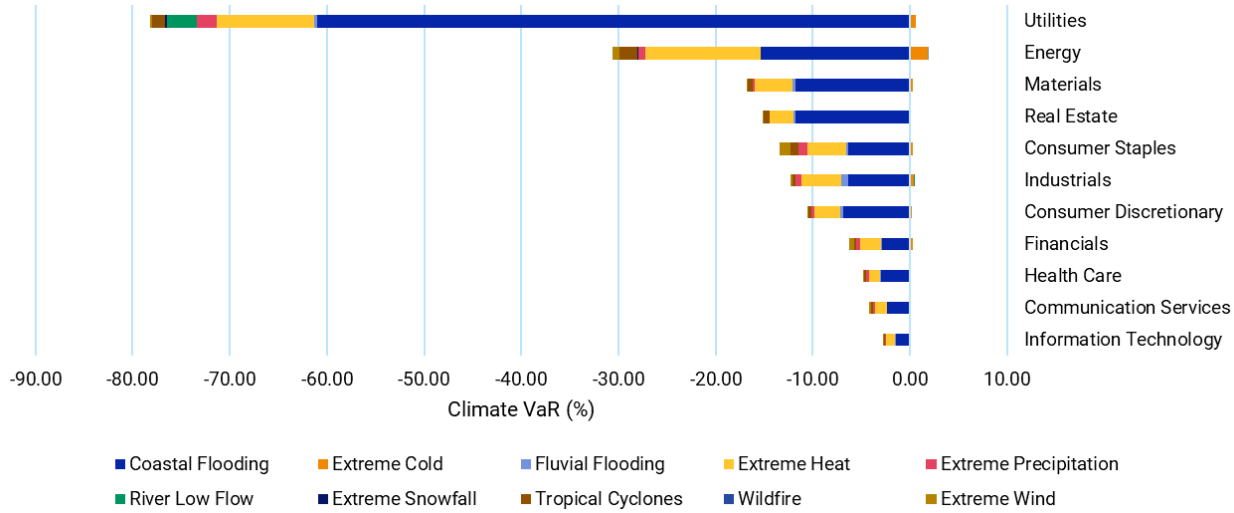
Exhibit 18: Physical risk Climate VaR for FY2023 domestic equity portfolio per hazard type



Note: The total value is the sum of Climate VaR of each hazard type but it does not equal to aggregated physical VaR shown in exhibit 16, partly because we consider correlation among different hazard types when we calculate aggregated physical risk Climate VaR.

Source: MSCI ESG Research, as of June 2024.

Exhibit 19: Physical risk Climate VaR for FY2023 domestic equity portfolio per hazard type per sector (NGFS 2°C Orderly)



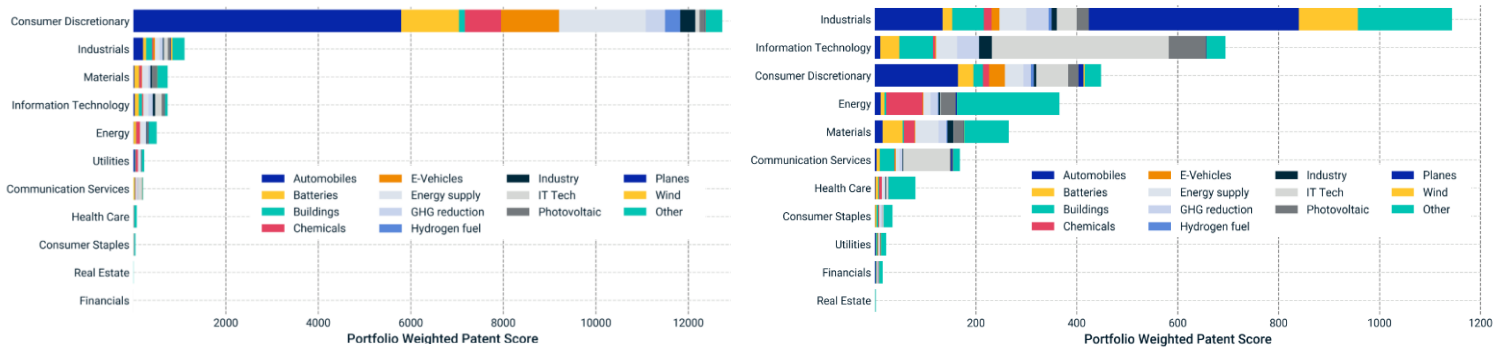
Source: MSCI ESG Research, as of June 2024.

Patent analysis

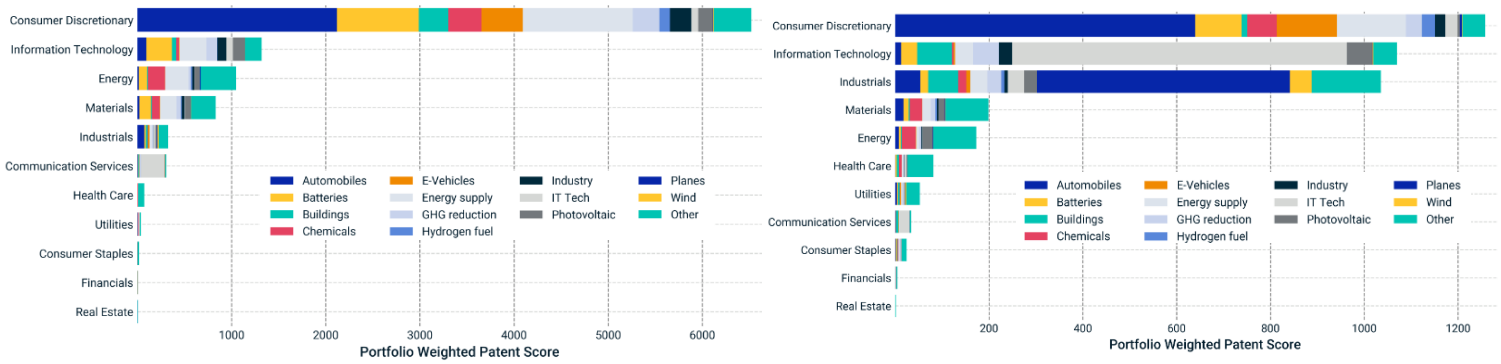
The portfolio weighted low-carbon patent score showed a relatively high score in domestic equity portfolio in the consumer discretionary sector, especially under patent categories such as automobiles, batteries, chemicals, electric vehicles and energy supply (Exhibit 20). This could lead to domestic equity portfolio having a relatively large technology opportunity Climate VaR.

Exhibit 20: Low-carbon patent score per sector for FY2023 portfolios

Equity portfolio: Domestic equity (left), foreign equity (right)



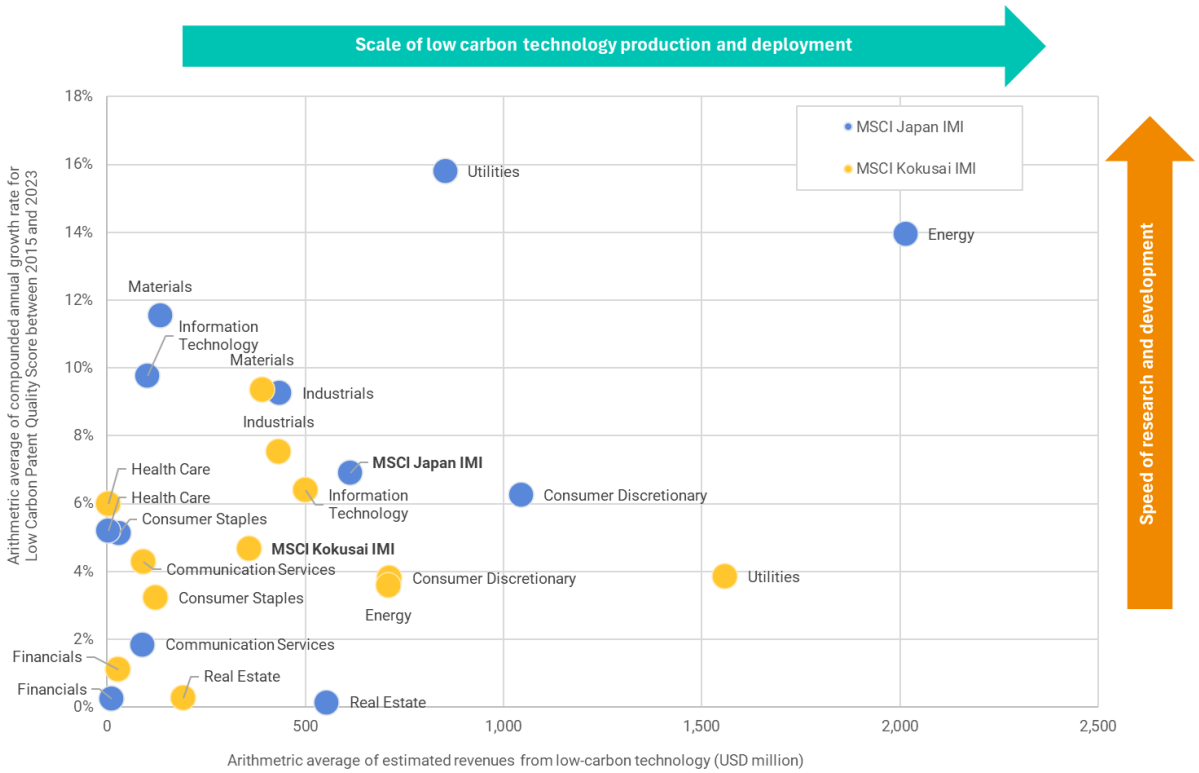
Corporate bond portfolio: Domestic corporate bond (left), foreign corporate bond (right)



Source: MSCI ESG Research, as of June 2024.

In addition, we assessed the speed and scale of the MSCI indexes constituents' low-carbon technology development and deployment, using compounded annual growth rates (CAGR) of low-carbon patent scores as a proxy for the speed of technology development and estimated revenues from low-carbon technology as a proxy for the scale of technology deployment, for the MSCI Japan IMI and the MSCI Kokusai IMI (Exhibit 21). The constituents of the MSCI Japan IMI showed relatively higher amount of estimated revenues from low carbon technology as well as higher growth of the patent scores than the MSCI Kokusai IMI constituents.

Exhibit 21: Speed and scale for low-carbon technology development and deployment for the MSCI Japan IMI and the MSCI Kokusai IMI per GICS sector



Note: We estimated the CAGR of low-carbon patent scores based on the time series of the scores between 2015 and 2023. We multiplied the percentage of sustainable impact revenues with a company's latest annual sales. To convert a company's revenue into USD, we use the exchange rate of the company's reported period end date. Source: MSCI ESG Research, as of June 2024.

Analysis of sovereign bond portfolio

We analyzed the potential impact of climate change and economic decarbonization on sovereign bonds using the MSCI Sovereign Bond Climate VaR.[31] The MSCI Sovereign Bond Climate VaR estimates the change in the sovereign yield curve when market expectations move from a climate-agnostic baseline expectation to any other climate scenarios. We use the framework put forward by NGFS and their scenarios for interest rates under various climate change scenarios. Similar to the previous year, we used the NGFS phase 3 scenarios for analysis on sovereign bond portfolio.[32] (Phase 4 is not yet available for the MSCI Sovereign Bond Climate VaR as of June 2024 even as pro forma data.)

Based on the NGFS scenarios, we derive potential shocks to sovereign bond yield curves, and, using our stress testing capabilities, we use these shocks to reprice sovereign bonds in our Sovereign Bond Climate VaR model. These scenarios predominantly focus on transition risks and incorporate to some extent the impact of chronic physical risks.[33] Acute physical risks are not yet part of the macroeconomic modeling in the NGFS scenarios.

The workflow:

- We base the scenarios on interest rate projections for the one- and ten-year sovereign interest rate in the NGFS scenarios. Those scenarios include a range of climate scenarios and a climate-agnostic baseline scenario.
- We estimate how today's yield curve would look if markets priced a given scenario and its interest rate projections.
- We examine the "shock" that the difference between the implied yield curve from a climate scenario and the baseline scenario gives us, which we would observe if markets changed expectations from the climate-agnostic baseline to a particular climate scenario.
- We input this yield-curve shock into a stress test that reprices a universe of sovereign bonds. The inflation shocks are included in a similar way.

We ran an analysis for GPIF's portfolio as of the end of March 2024 (FY2023), using phase 3 scenarios, and compared the result with that of the FY2022 portfolio, which was included in our report last year, "2023 Analysis of Climate Change-Related Risks in the GPIF's Portfolios" (July 2023). Since the analysis for FY2022 was also based on the phase 3 scenarios, the same yield-curve shocks were applied in the analysis for FY2023. While the order of scenarios by PnL impact did not change, FY2023 results moved in an overall positive direction from FY2022. This can be attributed to multiple factors. The change in the composition of the portfolio had a minor impact, as the newly added positions had similar PnL to the portfolio that remained constant (76% of weight by market capitalization). These bonds that remained in the portfolio year over year (YoY), aged by one year, their duration shortened (please see the change in weighted average duration in the

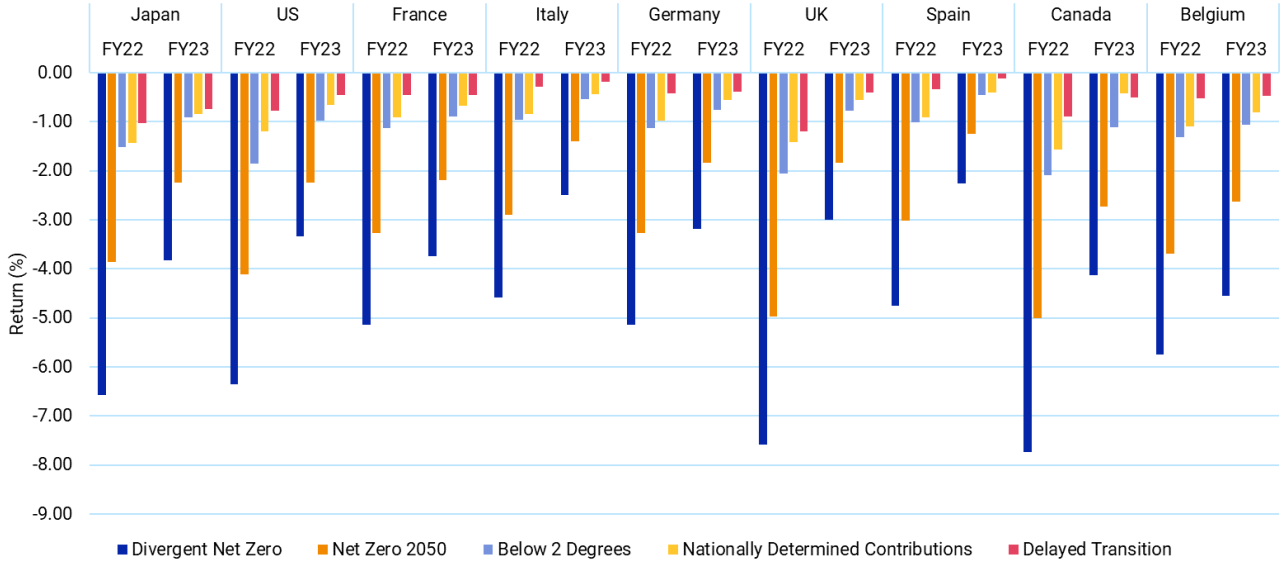
[31] Scenarios analysis under the MSCI Sovereign Bond Climate Value-at-Risk predominantly focuses on transition risks and incorporate to some extent the impact of chronic physical risks, but acute physical risks or low carbon technology opportunities were not yet part of the macroeconomic modeling in the NGFS scenarios.

[32] Please note that the results were based on pro forma data that we computed for GPIF as of June 2024. The results using the published data may differ from the results based on pro forma data.

[33] Chronic physical risks are related to longer-term shifts in climate patterns, such as sustained higher temperatures, that may cause a rise in sea level or chronic heat waves.

appendix). Given that duration measures the sensitivity of the price of a bond to a change in interest rates, PnL in a bond can be described as duration multiplied with yield-curve shocks as an approximation. Thus, shortened durations may be a possible reason behind the less negative PnLs in FY2023 compared to FY2022. Another source of change could be the change in the level of interest rates, as the same yield-curve shock applied to a different level of yield curve will change the PnL (keeping the bond constant). In Japan and U.S., the two regions most heavily represented in the portfolio, their rates went up YoY (please see the appendix), which decreased the duration of those bonds (ceteris paribus) and made them less sensitive to yield-curve shocks.

Exhibit 22: Sovereign Climate VaR results: FY2023 vs FY2022



Source: MSCI ESG Research, as of June 2024.

We took a closer look at the results for Japanese and U.S. sovereign bonds, as those two countries accounted for the highest portion of holdings: Japan for about half and U.S. for about a quarter in FY2023 sovereign bonds portfolio of GPIF. Both Japan and U.S. experienced the largest impacts under the Divergent Net-Zero scenario. Also, both countries' relatively longer maturity bonds (in buckets 10–20 years and 20+ years) experienced the largest impact.

Exhibit 23: Sovereign Bond Climate VaR results for Japanese bonds in the FY2023 portfolio per time to maturity buckets (return %)

Time to Maturity	Weight	Net-Zero 2050	Below 2 Degrees	Divergent Net-Zero	Delayed Transition	NDC
1 year	4.5%	-0.08	-0.03	-0.04	0.00	-0.01
1-5 years	32.9%	-0.72	-0.21	-1.08	-0.09	-0.23
5-10 years	25.1%	-2.06	-0.72	-3.55	-0.28	-0.79
10-20 years	24.1%	-3.61	-1.52	-6.41	-0.94	-1.39
20+ years	13.4%	-4.68	-2.20	-7.66	-3.13	-1.76
Total	**100.0%**	**-2.25**	**-0.91**	**-3.82**	**-0.74**	**-0.84**

Note: Weight assumes that the portfolio consists of only Japanese sovereign bonds.

Source: MSCI ESG Research, as of June 2024.

Exhibit 24: Sovereign Bond Climate VaR results for U.S. bonds in the FY2023 portfolio per time to maturity buckets (return %)

Time to Maturity	Weight	Net-Zero 2050	Below 2 Degrees	Divergent Net-Zero	Delayed Transition	NDC
1 year	0.8%	-0.60	-0.25	-0.99	0.00	-0.17
1-5 years	56.0%	-1.05	-0.41	-1.52	-0.03	-0.25
5-10 years	21.7%	-2.73	-1.09	-3.94	-0.14	-0.72
10-20 years	8.9%	-4.69	-2.13	-7.20	-1.20	-1.55
20+ years	12.5%	-5.16	-2.56	-7.90	-2.40	-1.76
Total	**100.0%**	**-2.25**	**-0.98**	**-3.35**	**-0.45**	**-0.66**

Note: Weight assumes that the portfolio consists of only U.S. sovereign bonds.

Source: MSCI ESG Research, as of June 2024.

In summary:

- GPIF's portfolio including corporate equity and bond had the largest positive Climate VaR under 1.5°C Disorderly (Divergent Net-Zero) scenario due to relatively high technology opportunities offsetting relatively high policy risks. Among four asset classes, domestic equity portfolio showed the largest technology opportunity Climate VaR, especially under 1.5°C scenarios, which was partly driven by a relatively high low-carbon patent score. But domestic equity portfolio had relatively large negative physical risk Climate VaR under higher temperature scenarios. Coastal flooding and extreme heat show relatively large risks among hazard types.
- GPIF's sovereign bond portfolio had the largest negative return under 1.5°C Disorderly (Divergent Net-Zero) scenario because scenario analysis under the MSCI Sovereign Bond Climate VaR predominantly focuses on transition risks. While the order of scenarios by PnL impact did not change from FY2022 results, FY2023 results moved in an overall positive direction from FY2022. Possible reasons behind the less negative PnLs in FY2023 compared to FY2022 include shortened durations.

Analysis of nature-related risks

This section provides an analysis of biodiversity-related investment risks and impacts from GPIF's equity portfolios using several MSCI tools included in our "Nature & Biodiversity Metrics" package. We cover issues such as how to report in line with some of the Taskforce on Nature-related Financial Disclosures' (TNFD's) core disclosure metrics, geospatial mapping, nature-related dependencies and opportunities, exposure to biodiversity-sensitive areas, exposure to potential risks related to deforestation, pressures on nature via "biodiversity footprinting" models and the extent to which corporate practices may reduce such pressures. Wherever possible, we conducted comparisons to relevant benchmarks.

Introduction

Nature risk can turn into business risk

Nature works for free, but its services are undervalued and overexploited. This may create new risks for investors.

Indeed, biodiversity and ecosystems are declining at an unprecedented rate[34]. The main direct drivers of biodiversity loss, as identified by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) are, in order of highest impact: changes in land and sea use, direct exploitation of organisms, climate change, pollution, and invasion by alien species. Behind these drivers are human behaviors such as consumption and production, population shifts, technological innovation, trade, and global governance.

Over half of the world's economic output relies on intact ecosystems, according to the World Economic Forum.[35] Some estimates, such as the 2018 WWF Living Planet report place this value as high as USD 125 trillion. Industries such as forestry, agriculture, fishery, and utilities are highly dependent on natural capital, while sectors such as information technology and banking are less directly dependent. Biodiversity loss can lead to reduced resilience in food production, limit pharmaceutical discoveries, threaten water security, and cause significant losses in staple crop production.

For companies and, in turn, investors, biodiversity loss poses risks and opportunities. It can impact businesses through pollution, GHG emissions, and reliance on ecosystem services. Companies that negatively impact nature can elevate risks for themselves and others, but they can also create opportunities by developing solutions to protect ecosystems.

Despite these potential impacts, nature-related risks and opportunities is a recent concern and many financial entities do not yet fully account for nature-related risks and opportunities.

A new regulatory focus

As a result, regulators and policymakers are increasingly focusing on financial risks related to biodiversity. Key initiatives include:

[34] Global Assessment Report on Biodiversity and Ecosystem Services, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019.

[35] "New Nature Economy Report." World Economic Forum. 2020.

- The 2022 Kunming-Montreal Global Biodiversity Framework aims to protect 30% of the planet's land and water by 2030 and requires companies and investors to disclose nature-related risks.
- The ISSB is considering sustainability-related risks and opportunities associated with biodiversity loss.
- The EU's Biodiversity Strategy for 2030, deforestation-free product requirements, and the EU Taxonomy include biodiversity protection as a criterion for sustainable economic activities.
- The Sustainable Finance Disclosure Regulation and the European Sustainability Reporting Standards require financial market participants to disclose biodiversity-related impacts.
- France's Article 29 of the Energy-Climate Law mandates biodiversity-related risk disclosures for financial firms.
- The UK's Environment Act bans the use of commodities produced on illegally used land.

These regulatory measures aim to address the economic, business, and investment impacts of biodiversity loss.

A new milestone in global disclosure: The TNFD framework

In addition to this evolving regulatory landscape, the launch of the TNFDs' comprehensive framework for companies and investors in 2023 represents a significant advancement in global disclosure practices. This framework includes disclosure recommendations and practical guidance for assessing and integrating biodiversity risks and opportunities into business and investment decisions. It is noteworthy that Japan produced the largest cohort of companies and investors committed to becoming "early adopters" of the TNFD framework in January 2024.[36]

The TNFD framework builds on the concepts developed by the TCFD, standardizing reporting on nature-related governance, strategy, risk and impact management, metrics and targets. Although the framework is voluntary, it has the potential to become a market standard, similar to how the TCFD became the global benchmark for corporate climate disclosure.

Key components of the TNFD framework include a core set of 14 indicators for cross-sector reporting and recommendations for sector-specific reporting. In addition, it suggests a set of supplementary disclosure metrics for organizations to use as needed. To align with TNFD, businesses and investors should at least report data for the core disclosure metrics.

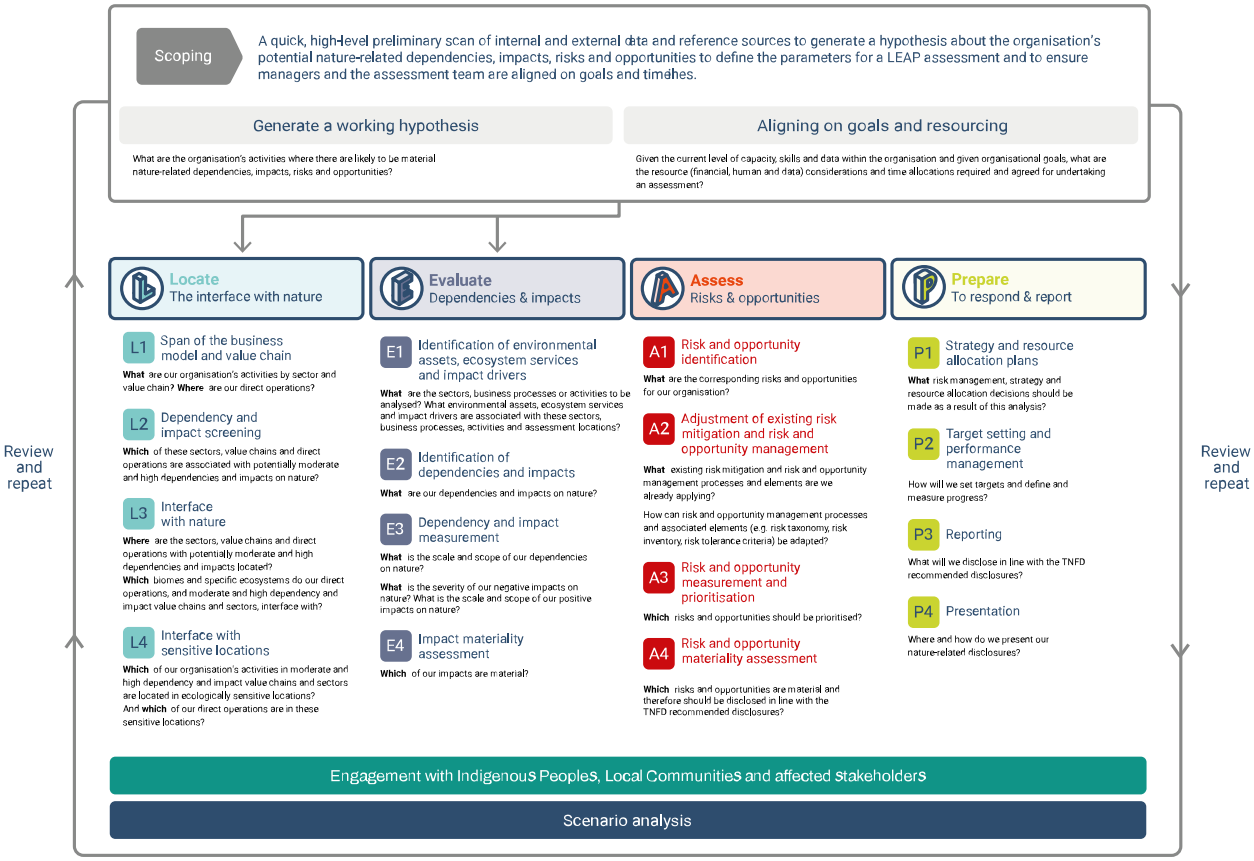
The TNFD has also introduced the LEAP approach for structured reporting and management of nature-related disclosures. LEAP stands for:

- Locate your interface with nature.
- Evaluate your dependencies and impacts on nature.
- Assess your nature-related risks and opportunities.
- Prepare to respond to nature-related risks and opportunities and to report on your material nature-related issues.

[36] " 320 companies and financial institutions to start TNFD nature-related corporate reporting," TNFD, January 2024.

The “L” in LEAP highlights the importance of location-specific data, as the impact on biodiversity and nature varies significantly based on the geographic location of a company's operations.

Exhibit 25: TNFD LEAP approach

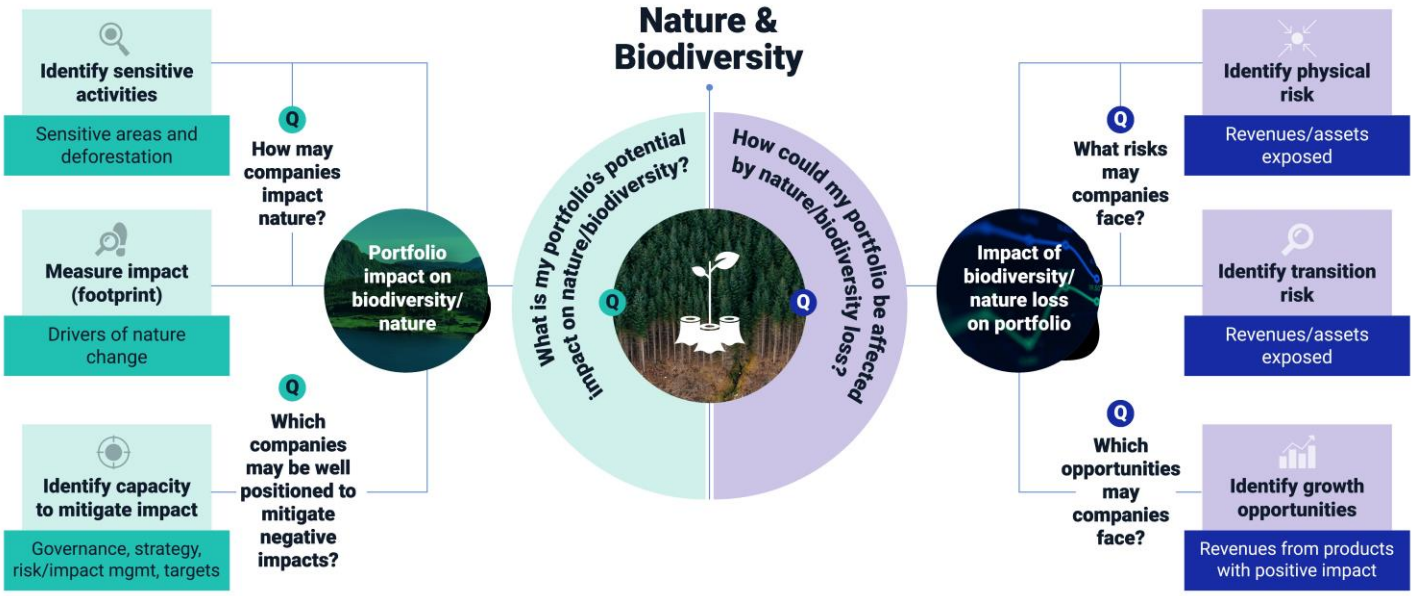


Source: TNFD, “Recommendations of the Taskforce on Nature-related Financial Disclosures.” 2023.

Nature risk is investment risk

MSCI developed a Nature & Biodiversity Metrics Framework that is designed to help investors navigate the various metrics and models to begin incorporating nature and biodiversity issues into their investment process. Similar to MSCI’s Climate metrics framework, investors may start by choosing metrics based on two overarching questions: “*What is my portfolio’s potential impact on biodiversity and nature*?” and “*How could my portfolio be affected by biodiversity and nature loss?*”

Exhibit 26: MSCI's Nature & Biodiversity Metrics Framework



Source: MSCI ESG Research, as of May 2024.

From here, investors may use different metrics to address specific questions and investment objectives:

Impact on nature and biodiversity:

- How to identify activities of investee companies that could lead to nature/biodiversity loss?
- How to measure the negative impact of investee companies on biodiversity and nature?
- How to assess investee companies' management capacity to mitigate potential negative impacts?

Impact of nature and biodiversity loss:

- How to assess investee companies' exposure to nature-related risks?
- How to identify investment opportunities related to growing demand for products and services that help tackle the biodiversity crisis?

This section addresses some of these questions.

Overcoming the data challenge

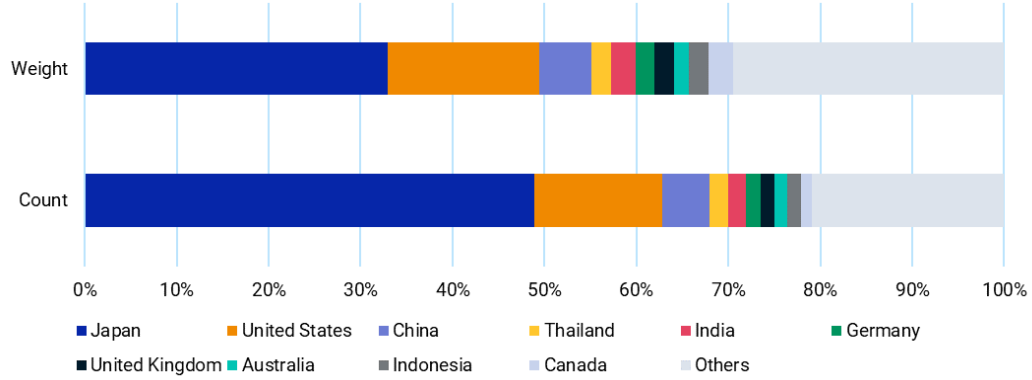
Investors are faced with heightened data challenges when striving to answer these questions. Quantifying financial implications from biodiversity loss is complex due to multiple pressures and the need for geospatial data. Assessing a portfolio's dependency on ecosystem services requires advanced models and granular, geocoded data. Nature-related risks can have reverberating effects that complicate financial risk assessments. Further, key data points are often undisclosed or inaccurate, especially in supply chains. Nonetheless, as evidenced in this report, an increasing number of financial institutions have begun integrating biodiversity data and models into investment decisions.

Geospatial mapping of GPIF assets against biodiversity-sensitive areas

Unlike carbon emissions in relation to climate change, biodiversity-loss drivers and impacts are inherently local. This is why implementing the TNFD "LEAP" framework begins with "Locating" economic activities within a given investment portfolio, then comparing those activities to biodiversity-related considerations.

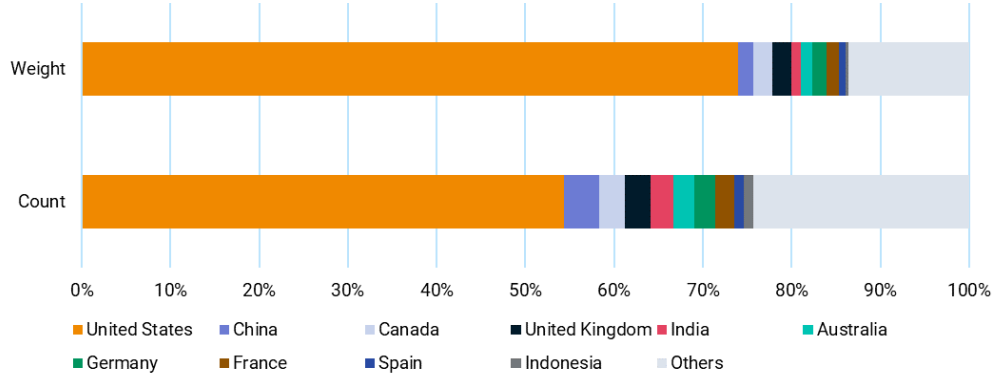
With this in mind, we have first mapped the GPIF assets using MSCI GeoSpatial to identify geographical concentrations. As can be expected, comparing foreign equities to domestic equities reveals a significantly different geographical distribution of the individual assets underlying each company in the portfolio, with foreign equities producing far larger exposures to North America and Europe, the Middle East and Africa. The two following diagrams show that this skew is visible both in terms of issuer count and portfolio weighted count.

Exhibit 27: Proportion of assets per region for FY2023 domestic equity portfolio



Note: "Weight" in Y-axis shows the portfolio-weighted (issuer weighting) number of assets in each region, whereas "Count" shows the simple ratio of assets in each region. Source: MSCI ESG Research, as of May 2024.

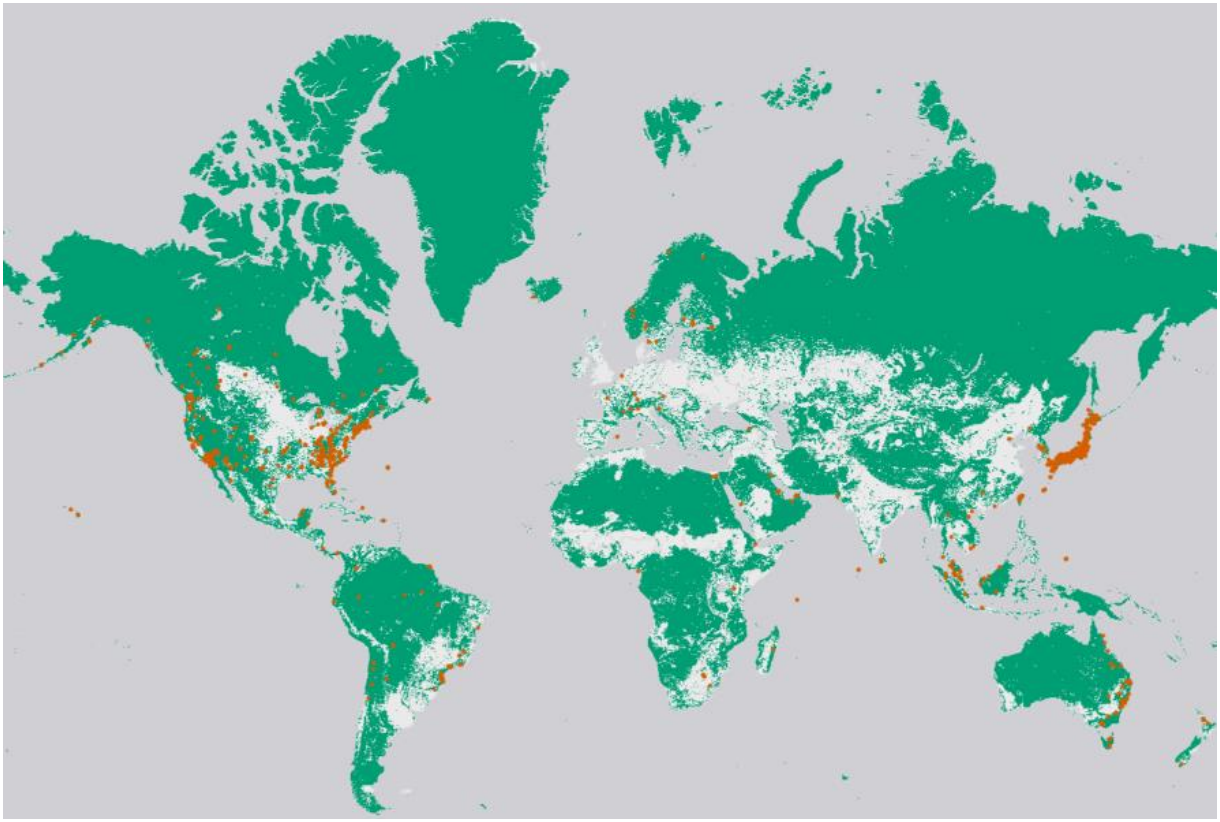
Exhibit 28: Proportion of assets per region for FY2023 foreign equity portfolio



Note: "Weight" in Y-axis shows the portfolio-weighted (issuer weighting) number of assets in each region, whereas "Count" shows the simple ratio of assets in each region. Source: MSCI ESG Research, as of May 2024.

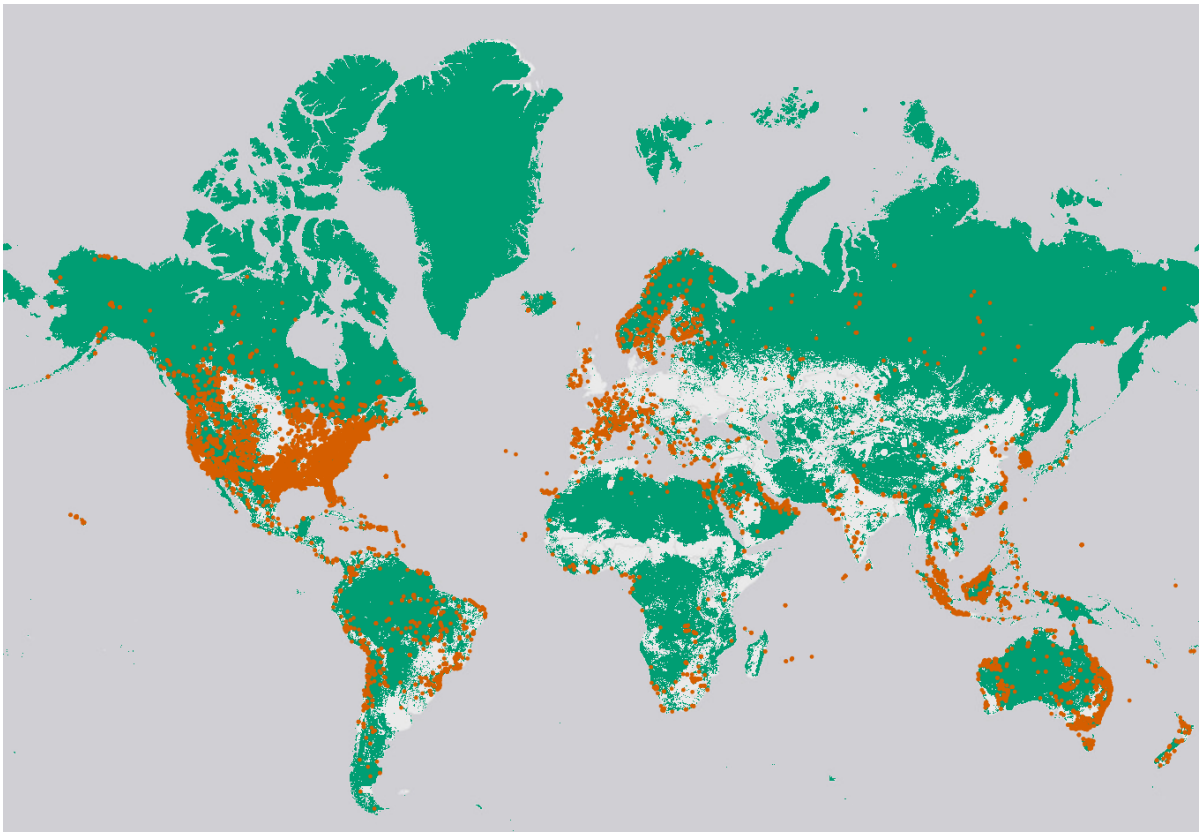
We then compare those weighted locations to biodiversity-sensitive areas (BSAs) based on a combination of four layers: deforestation fronts, intact areas, healthy forests, prime conservation areas. This results in much more exposure to BSAs in foreign equities compared to domestic equities portfolios. This is particularly marked in parts of U.S. and Australia and, to a lesser extent, in Northern Europe. Taking those factors into account using such mapping is a key requirement when striving to integrate biodiversity criteria into investment decisions.

Exhibit 29: Asset location map for FY2023 domestic equity portfolio



Note: Orange dots indicate an asset in a BSA, which is colored green. Source: MSCI ESG Research, as of May 2024.

Exhibit 30: Asset location map for FY2023 foreign equity portfolio



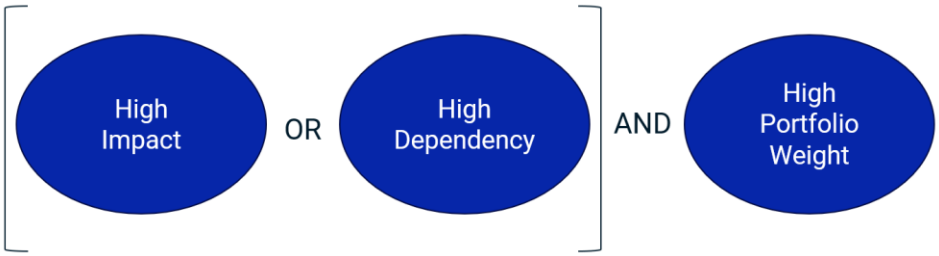
Note: Orange dots indicate an asset in a BSA, which is colored green. Source: MSCI ESG Research, as of May 2024.

Materiality assessment: Identifying high-risk industries

Industries apply varying pressures on nature, both in terms of type and volume, with some sectors, such as food and agriculture, significantly impacting biodiversity via land-use change and water consumption. Other sectors, such as electric utilities and chemicals, exert pressure on biodiversity via their contribution to climate-related second order impacts, such as drought or local pollution risks. Furthermore, some sectors depend more significantly than others on nature-related inputs, such as ecosystem services. In parallel, the investment exposure should also be considered when assessing those pressures and risks.

This is why we have developed a materiality assessment using the following steps:

Exhibit 31: Steps to define high-risk industry

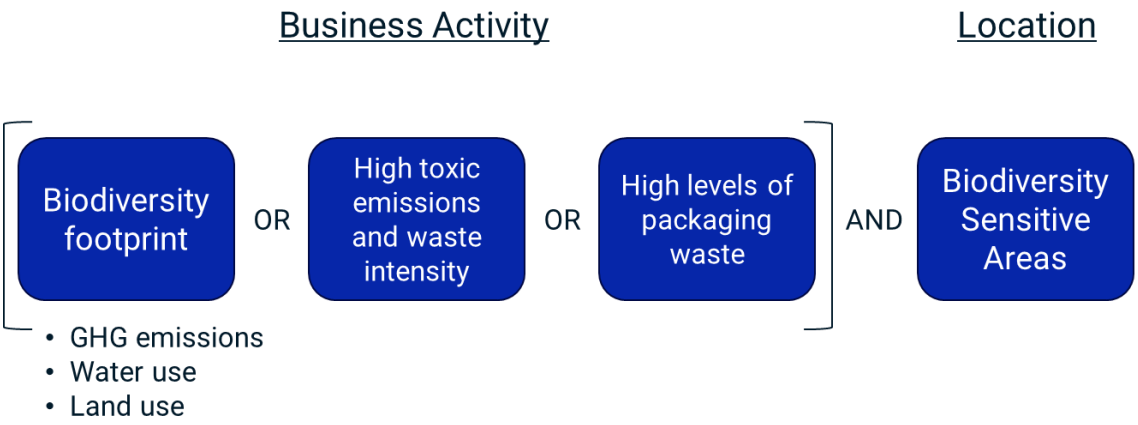


Source: MSCI ESG Research

We defined our approach by combining impact, dependencies and portfolio weight.

Step 1: Defining high-impact industry

Exhibit 32: Defining high-impact industry



Source: MSCI ESG Research

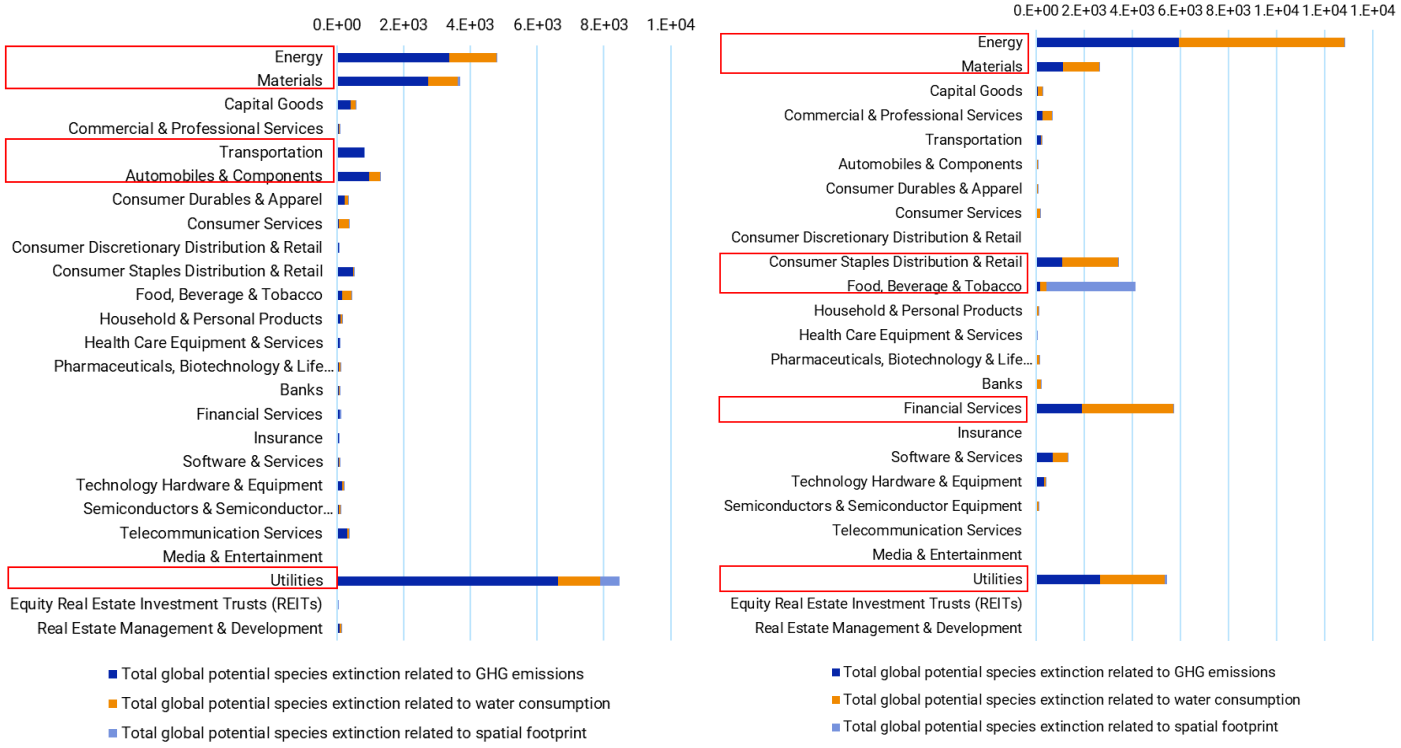
We defined "high-impact" industry by combining factors related to biodiversity footprint and other nature-related issues (e.g., toxic emissions, waste) and BSAs. We flagged industries that have higher value than overall portfolio weighted average for domestic equity portfolio and foreign equity portfolio.

Step 1.1 Biodiversity footprinting

We used a new MSCI tool leveraging the Potentially Disappeared Fraction of Species (PDF) academic model to define the biodiversity footprint of individual portfolio companies. This model is further developed in the "Biodiversity footprinting" section (page 43). Our analysis of domestic and foreign equity portfolios showed that a small number of sectors bore an outsize PDF compared to other sectors, representing excessive pressures on biodiversity according to the PDF model (Exhibit 33).

Exhibit 33: Total PDF per GICS industry group for FY2023 portfolio

Domestic equity (left) and foreign equity (right)



Note: The PDF value is portfolio weighted. GICS industry groups that had higher PDF than overall PDF for each portfolio are surrounded by a red square. Source: MSCI ESG Research, as of May 2024.

Step 1.2 Toxic emissions and waste

We identified which industries were more likely to exert the most pressure on biodiversity via key factors: toxic emissions, waste intensity and packaging waste. Again, this analysis revealed that some industries contributed to such pollution more excessively than others (Exhibit 34).

Exhibit 34: Estimated percentage of operations in segments with high toxic emissions and waste intensity[37] and revenues from products with high levels of packaging waste per GICS industry group

Domestic equity (left) and foreign equity (right)

	High toxic emissions and waste intensity (%)	High levels of packaging waste (%)
Total	19.0	6.6
Energy	82.7	0.0
Materials	70.0	5.2
Capital Goods	18.5	3.9
Commercial & Professional Services	1.7	3.6
Transportation	17.1	5.9
Automobiles & Components	79.8	0.0
Consumer Durables & Apparel	10.7	0.2
Consumer Services	0.1	35.2
Consumer Discretionary Distribution & Retail	0.0	53.6
Consumer Staples Distribution & Retail	0.0	9.4
Food, Beverage & Tobacco	0.2	73.7
Household & Personal Products	7.7	86.4
Health Care Equipment & Services	0.1	0.0
Pharmaceuticals, Biotechnology & Life Sciences	0.0	2.2
Banks	0.0	0.0
Financial Services	0.2	0.7
Insurance	0.0	0.0
Software & Services	0.0	0.0
Technology Hardware & Equipment	8.1	0.0
Semiconductors & Semiconductor Equipment	14.0	0.0
Telecommunication Services	0.0	0.0
Media & Entertainment	0.3	0.9
Utilities	23.8	0.0
Equity Real Estate Investment Trusts (REITs)	0.0	0.0
Real Estate Management & Development	0.0	0.0

	High toxic emissions and waste intensity (%)	High levels of packaging waste (%)
Total	11.6	7.3
Energy	75.8	0.0
Materials	69.7	9.0
Capital Goods	32.5	0.4
Commercial & Professional Services	17.3	0.1
Transportation	5.1	0.0
Automobiles & Components	88.5	0.1
Consumer Durables & Apparel	1.4	9.6
Consumer Services	2.9	39.0
Consumer Discretionary Distribution & Retail	0.2	34.1
Consumer Staples Distribution & Retail	0.0	18.0
Food, Beverage & Tobacco	0.3	80.3
Household & Personal Products	0.9	87.9
Health Care Equipment & Services	0.0	1.3
Pharmaceuticals, Biotechnology & Life Sciences	0.5	0.0
Banks	0.0	0.0
Financial Services	0.5	0.0
Insurance	0.1	0.0
Software & Services	0.0	0.0
Technology Hardware & Equipment	1.6	0.0
Semiconductors & Semiconductor Equipment	0.3	0.0
Telecommunication Services	0.0	0.0
Media & Entertainment	0.0	0.0
Utilities	19.6	0.0
Equity Real Estate Investment Trusts (REITs)	1.9	0.0
Real Estate Management & Development	0.1	0.9

Note: The percentage is portfolio weighted. GICS industry groups that had higher percentage than overall percentage for each portfolio are surrounded by a red or blue square. Source: MSCI ESG Research, as of May 2024.

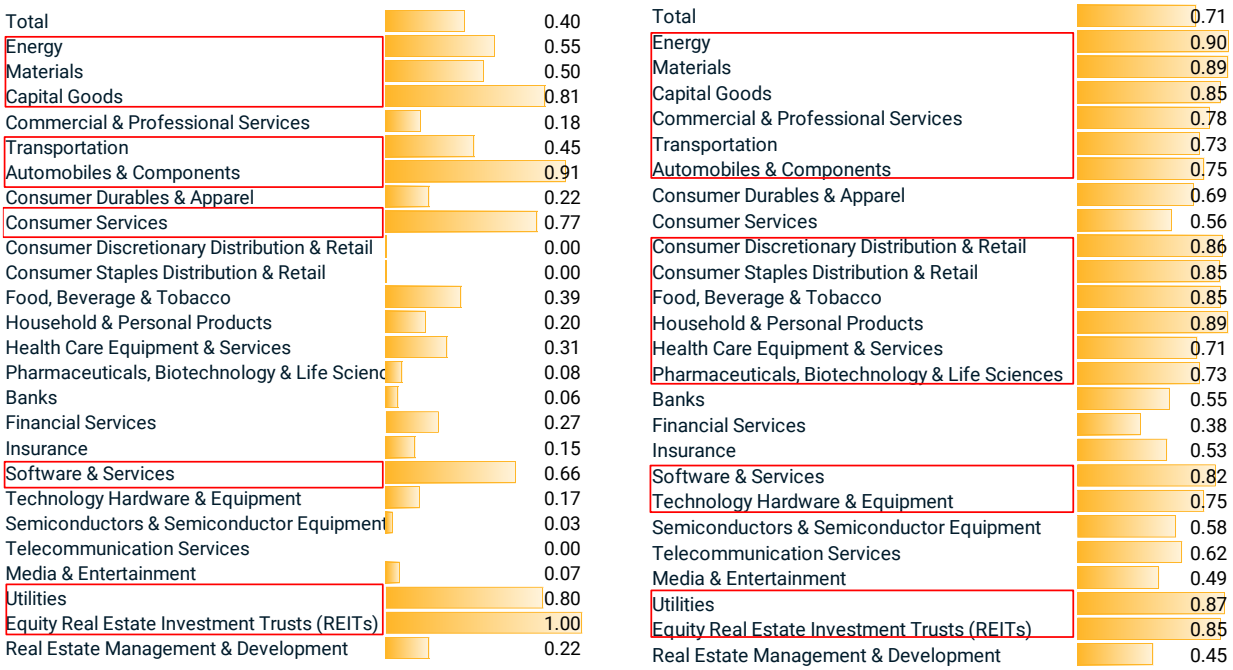
Step 1.3 Operations in BSAs

The MSCI Biodiversity Areas Screening Metrics tool enables us to identify which issuers have operations in BSAs (defined as deforestation fronts, intact areas, healthy forests, prime conservation areas). This step revealed which sectors had the most operations in sensitive areas (Exhibit 35). The foreign equity portfolio contributed far more to these pressures, as we have seen using the initial geospatial analysis.

[37] This represents the portion of the company's operations in lines of business that typically generate large amounts of toxic emissions, per our model.

Exhibit 35: Portfolio weights of flagged issuers under BSA per GICS industry group

Domestic equity (left) and foreign equity (right)



Note: GICS industry groups that had higher percentage than overall percentage for each portfolio are surrounded by a red square. Source: MSCI ESG Research, as of May 2024.

Step 2: Define high-dependencies sectors

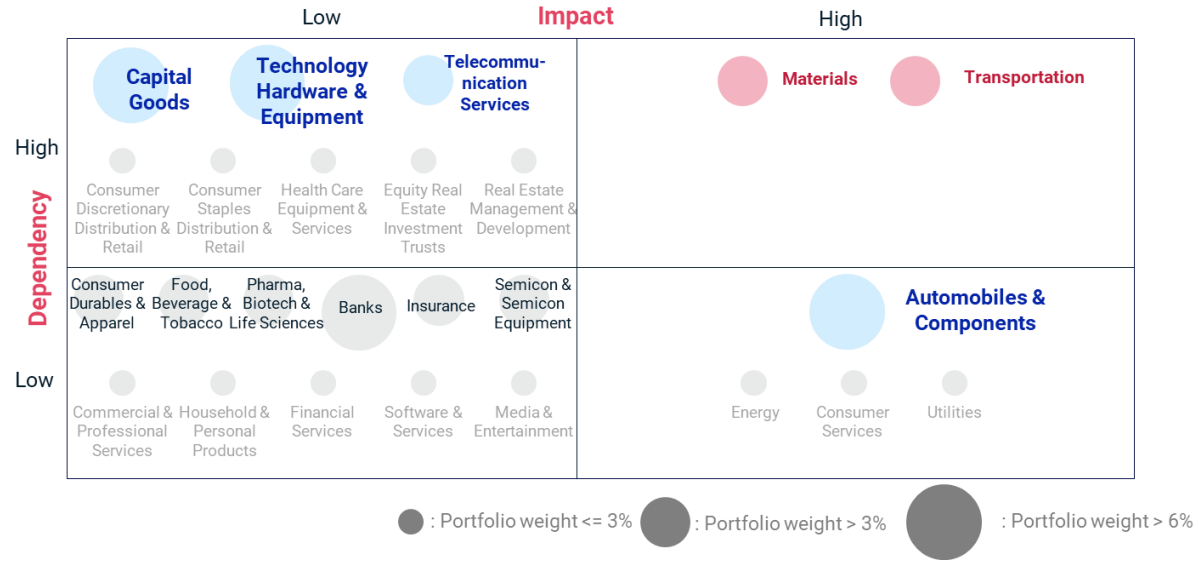
In the second step, the analysis leveraged a "dependency" (on ecosystem services) analysis conducted by GPIF (please refer to "GPIF 2023 ESG Report" for details), which produced a shortlist of industries deemed representative of the highest risk of dependency on biodiversity factors.

Step 3: Factor portfolio weights

Finally, we combined the selected high-impact sectors with GPIF portfolio weights to define which industries represent both the highest impact and highest weight, delivering the final list of industries considered "high exposure" in terms of materiality assessment. These included, for example, materials and transportation for domestic equity and energy and food, beverage and tobacco for the foreign equity portfolio.

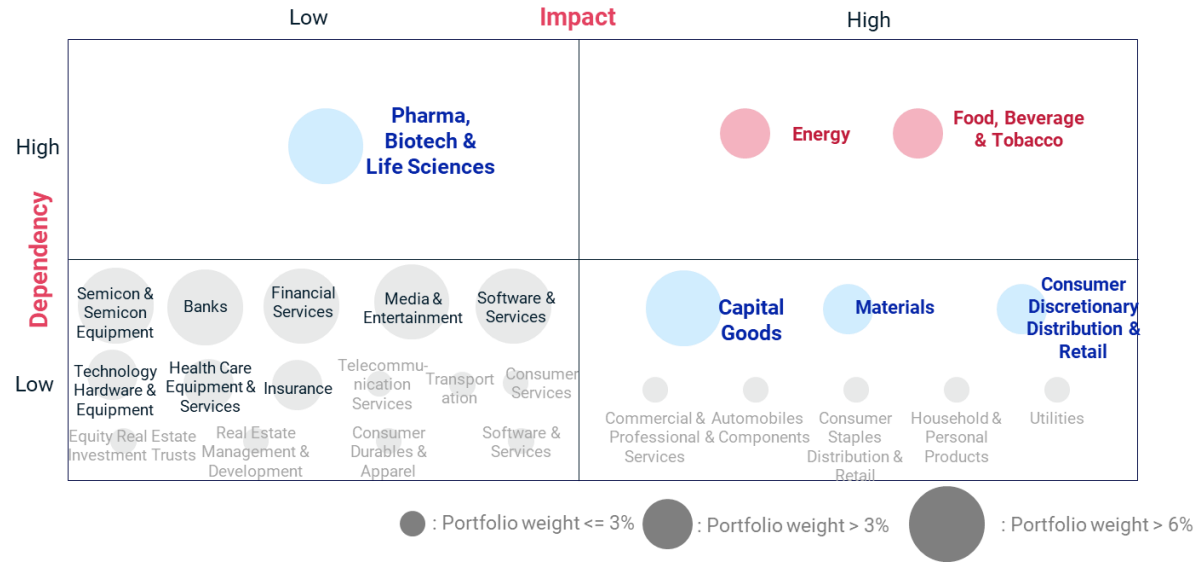
This approach to identifying the most material industries leveraged several metrics and models to help inform investment decisions in the context of TNFD-related materiality assessment, in the absence of robust economic dependency models.

Exhibit 36: Metrics to define high-risk industry for domestic equity



Note: We defined GICS industry groups that had high impact or high dependencies as high-risk industries, of which bubbles are colored in red or blue. Red bubbles are for industry groups that had both high impact and high dependencies. Blue bubbles are for those that had high dependencies or impact. Source: MSCI ESG Research, as of May 2024.

Exhibit 37: Metrics to define high-risk industry for foreign equity



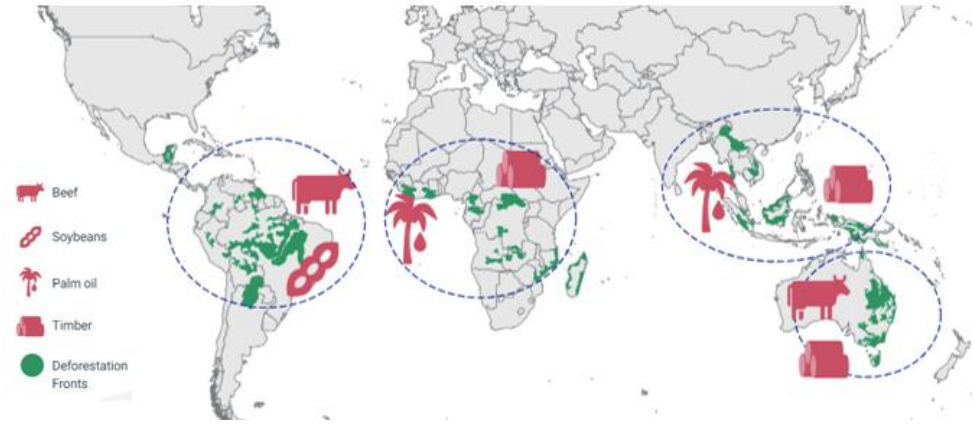
Note: We defined GICS industry groups that had high impact or high dependencies as high-risk industries, of which bubbles are colored in red or blue. Red bubbles are for industry groups that had both high impact and high dependencies. Blue bubbles are for those that had high dependencies or impact. Source: MSCI ESG Research, as of May 2024.

Deforestation

Deforestation is a key contributor to nature loss via habitat destruction and climate change via the loss of carbon sinks. It is also under significant scrutiny by policymakers and civil society, representing both legal and reputational risks.[38]

MSCI's Deforestation Screening Metrics indicate whether companies are flagged for deforestation-related risks by the production (direct contribution) or use of commodities (indirect contribution) that are considered key drivers of deforestation or as a result of direct operations in areas of high deforestation risk (direct) and involvement in deforestation-related controversies (direct). It captures commodities considered key drivers of deforestation: production/use of palm oil, soybean, beef or timber. We focus on physical assets in the World Wide Fund for Nature (WWF) "deforestation fronts" which is illustrated in Exhibit 38 for companies operating in a high-risk industry.

Exhibit 38: WWF deforestation fronts



Sources: WWF, "Deforestation fronts: Drivers and responses in a changing world report," 2021; IPBES, "Global assessment report on biodiversity and ecosystem services," 2019.

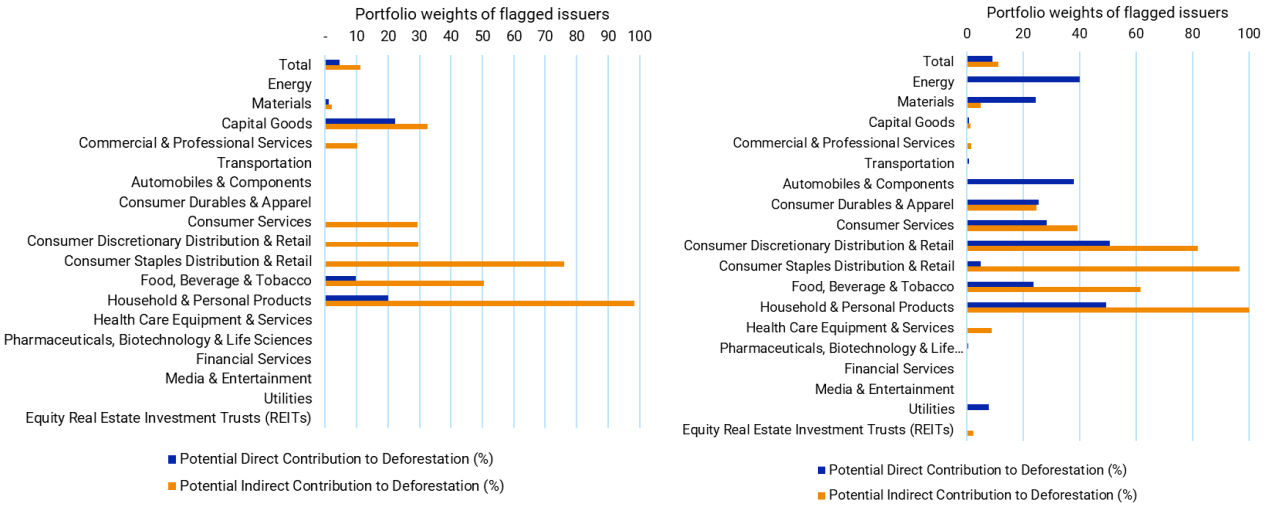
When applying this screener to GPIF's domestic equity portfolio, **we found that 5% of this portfolio's weighted issuers may be involved in deforestation via their direct operations, and up to 11% when including indirect deforestation ratio (i.e., via supply chains).** This was lower than the MSCI ACWI IMI direct deforestation ratio (8%) and in line with the indirect deforestation ratio. Naturally, when including deforestation risks related to the activities conducted by suppliers, certain industry groups such as consumer staples and household and personal products were flagged. Most of these impacts are connected to palm oil and timber production.

We noticed a similar result in the foreign equity portfolio, where potential indirect contribution to deforestation (11%) was higher than direct contribution (9%). However, those risks were spread across a wider number of industries, including energy; materials; automobiles; consumer durables and apparel; consumer services; consumer discretionary distribution and retail; consumer staples distribution and retail; food, beverage and tobacco; and household and personal products.

[38] The issue of deforestation has been discussed at climate and biodiversity conferences. More than 140 nations signed the Glasgow Leaders' Declaration on Forests and Land Use to halt and reverse forest loss and land degradation by 2030. (UN Climate Change Conference UK 2021. "Glasgow Leaders' Declaration on Forests and Land Use." Data as of Dec. 12, 2022.)

Exhibit 39: Portfolio weights of flagged issuers under Deforestation Screening Metrics per GICS industry group

Domestic equity (left) and foreign equity (right)



Note: In the above charts, we included only GICS industry groups that had more than 0% value in either domestic equity portfolio or foreign equity portfolio. Source: MSCI ESG Research, as of May 2024.

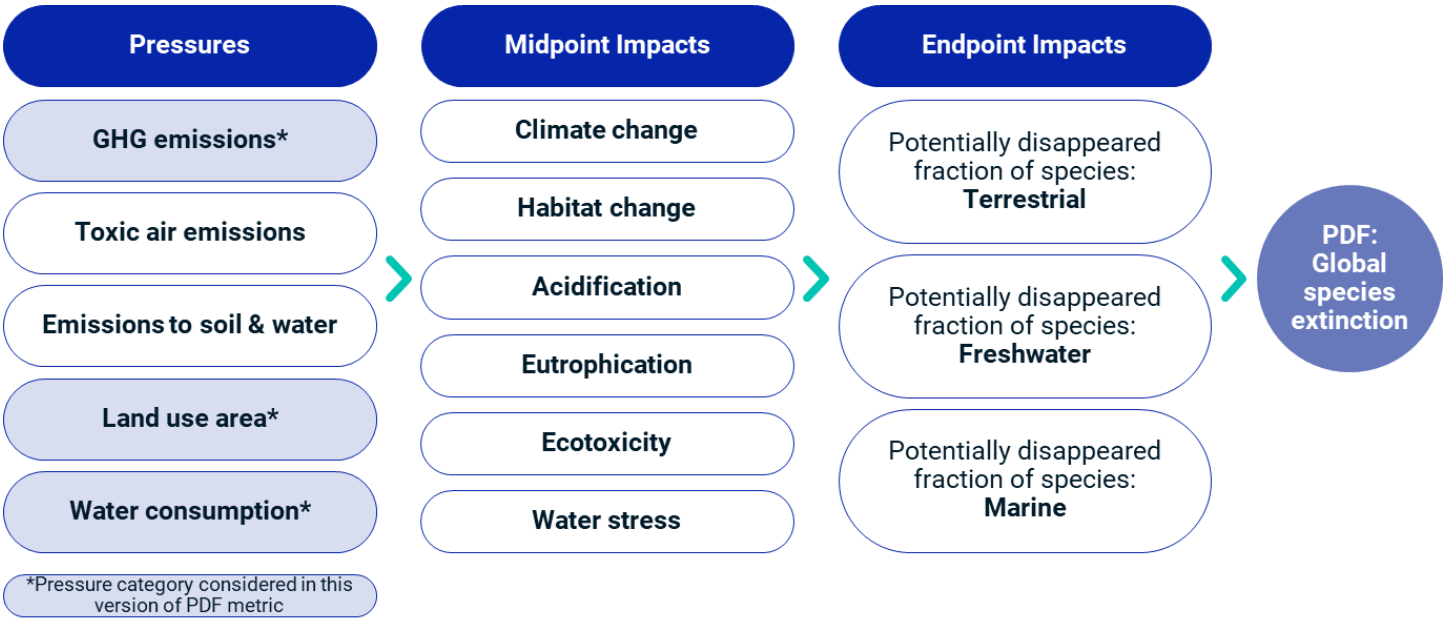
This analysis focused on a selection of commodities connected to a key driver of biodiversity loss that can be used to evaluate some of the most acute theme-specific, biodiversity-related risks. However, this analysis is most relevant when complemented with a sector or an issuer-level analysis of company-specific mitigation policies.

Biodiversity footprinting

Investors striving to quantify the impacts of their investments on biodiversity across sectors or portfolios increasingly rely on an approach called “biodiversity footprinting.” While there is no market consensus on such approaches yet, biodiversity footprinting generally refers to producing a quantified potential impact of a portfolio, asset class, project or company measured in terms of biodiversity change as a result of production and consumption of particular goods and services. This differs from the screening approaches (e.g., deforestation) that flag potential involvement in a given activity or location.

MSCI’s Biodiversity Footprint Metric leverages the “Potentially Disappeared Fraction of species” (PDF) model using species diversity as a proxy for the state of biodiversity. It indicates a company’s potential contribution to global species extinction due to pressures that may be caused by the company. These pressures are currently associated with land use, GHG emissions and water consumption. Once identified, these pressures are modeled via a lifecycle analysis into potential impacts that alter the state of nature and conditions across terrestrial, freshwater, or marine ecosystems. This analysis was done at each individual asset level and then aggregated at issuer and portfolio levels. For further details about MSCI’s Biodiversity Metrics, see Nature and Biodiversity: Identify and measure portfolio impacts and risks.

Exhibit 40: How to calculate PDF of species



Source: MSCI and based on life cycle assessment frameworks including: Verones F. et al., "LC-IMPACT: A Regionalized Life Cycle Damage Assessment Method," 2020; National Institute for Public Health and the Environment of the Netherlands, "ReCiPe 2016 v1.1: A Harmonized Life Cycle Impact Assessment Method at Midpoint and Endpoint Level," 2016.

This tool's output is expressed under three variants: a company's total PDF, an intensity metric normalized by revenue, and a percentile ranking metric that shows the PDF relative to a global benchmark. In this report we focused on total/absolute PDF. The PDF is expressed as a unitless fraction from zero (a fully undisturbed state of nature) to one (fully destroyed nature), as shown on Exhibit 41.

Exhibit 41: Potentially Disappeared Fraction (PDF) of species

Source: MSCI ESG Research, as of April 2024.

We used a scientific notation, which resulted in extremely small fractions. This is expected as any given company or even basket of issuers in a portfolio normally has a relatively small contribution to global species extinction — similar to an individual company's GHG emissions contribution to global climate change. Nonetheless, absolute figures and relative rankings can be derived from these small fractions. See Exhibit 33 for the output for GPIF FY2023 domestic and foreign equity portfolios.

When applied to the GPIF domestic equity portfolio, we found that a small number of GICS industry groups contribute significantly to the absolute PDF value. In particular, we noticed that energy, materials and utilities industry groups contributed most to the overall portfolio PDF, with GHG emissions being the largest proportion of pressures on nature, followed by water consumption and, to a much lesser extent, land use.

The foreign equity portfolio shows a different picture with a more widespread distribution of PDF pressures among sectors. Notably, the food, beverage and tobacco industry group rises as a key contributor to nature loss via the food industry's land use.

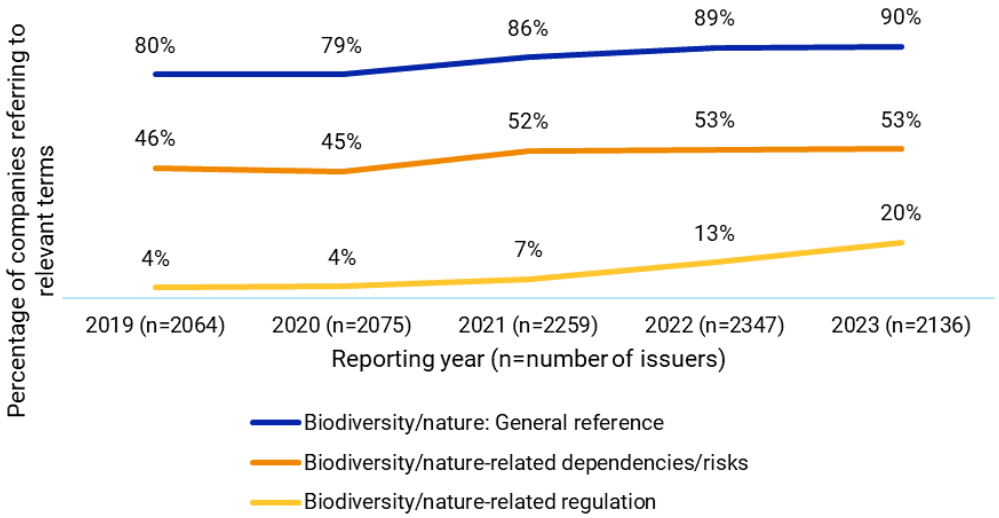
In summary, biodiversity footprinting is a new approach to measuring impact, factoring multiple pressure types and asset-level data. It will improve over time with the addition of extra pressure types and the growth of reported data thanks to the work of the TNFD.

Company awareness

While biodiversity-related risks and impacts can be modeled using some of the approaches outlined, company responses to such risks and impacts differ. To gain a better understanding of these strategies, we conducted an analysis of corporate disclosures. In this subsection, using natural language processing, we looked at what companies publish regarding biodiversity and nature in their annual filings.

The percentage of companies that referred to biodiversity-/nature-related terms, including general and specific terms related to dependencies/risks, at least once in their annual reports has increased since 2019 but has stayed relatively flat since the end of 2021. On the contrary, the percentage of companies that referred to biodiversity-/nature-related regulations and frameworks, such as the TNFD, has steadily increased, although the percentage remained relatively lower than that of companies referred to in the other two categories (biodiversity/nature: general reference and biodiversity-/nature-related dependencies/risks). This may indicate that, given the new regulatory focus, the companies have come to regard biodiversity-/nature-related issues as a more imminent regulatory risk that requires closer attention.

Exhibit 42: Reference to biodiversity and nature in annual reports

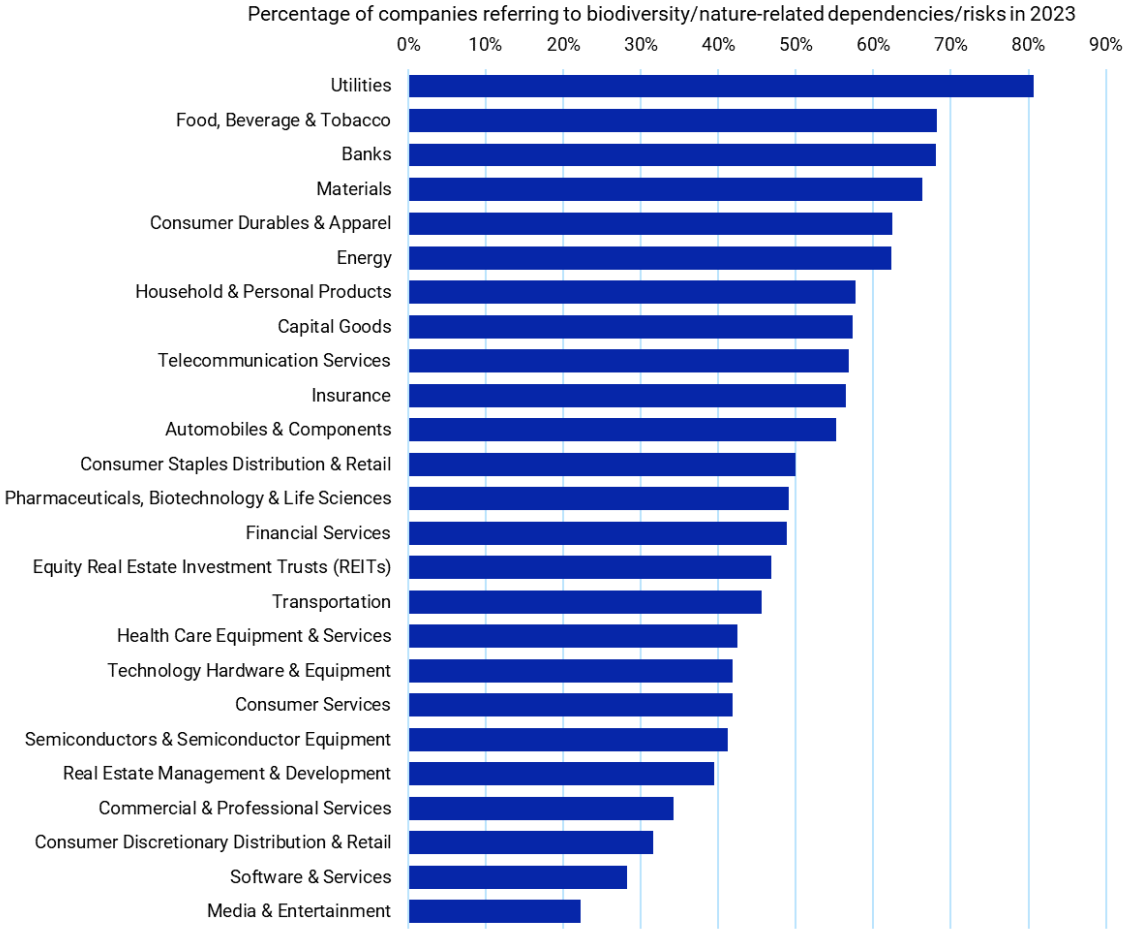


Note: Annual reports (in English) of the constituents of the MSCI ACWI Index published between FY2019 and FY2023, as of June 2024, were used in the analysis. This chart shows the percentage of companies that mentioned general terms related to biodiversity and nature, such as "biodiversity," or terms related to biodiversity-/nature-related dependencies/risks, such as "nature dependency," or biodiversity-/nature-related regulations and frameworks, such as "TNFD." Source: MSCI ESG Research.

Among GICS industry groups, utilities; food, beverage and tobacco; banks and materials had a relatively higher percentage of companies that referred to terms related to biodiversity-/nature-related dependencies/risks. Food, beverage and tobacco and materials GICS industry groups were defined as high-risk industries, and utilities was defined as high-impact industry in GPIF's FY2023 foreign equity portfolio in the "Materiality assessment: Identification of high-risk/high-exposure industry" section. Our research shows that issuers in "high-risk" and "high-impact" industries may pay more attention to those risks. Furthermore, although banks are not defined as either high impact or high dependencies in the above section, their disclosures refer significantly to biodiversity-/nature-related dependencies/risks. This likely does not relate to their own operations but rather to an awareness of their indirect impacts via their financing activities. Of note, a significant number of TNFD "early adopters" are financial institutions.[39]

[39] "320 companies and financial institutions to start TNFD nature-related corporate reporting." TNFD, January 2024

Exhibit 43: Reference to biodiversity-/nature-related dependencies/risks in annual reports per GICS industry group



Note: Annual reports (in English) of the constituents of the MSCI ACWI Index published in FY2023, as of June 2024, were used in the analysis. This chart shows the percentage of companies that mentioned terms related to biodiversity-/nature-related risks and dependencies such as nature dependency. Source: MSCI ESG Research.

Nature opportunities

All crises carry risks and opportunities. Similar to mitigating climate risks, where providers of low-carbon solutions may present attractive long-term investment opportunities, biodiversity loss can be mitigated by certain technologies and business practices. Here we looked into three revenue streams that are closely connected to nature conservation and biodiversity-loss mitigation: pollution prevention, sustainable agriculture and sustainable water management.

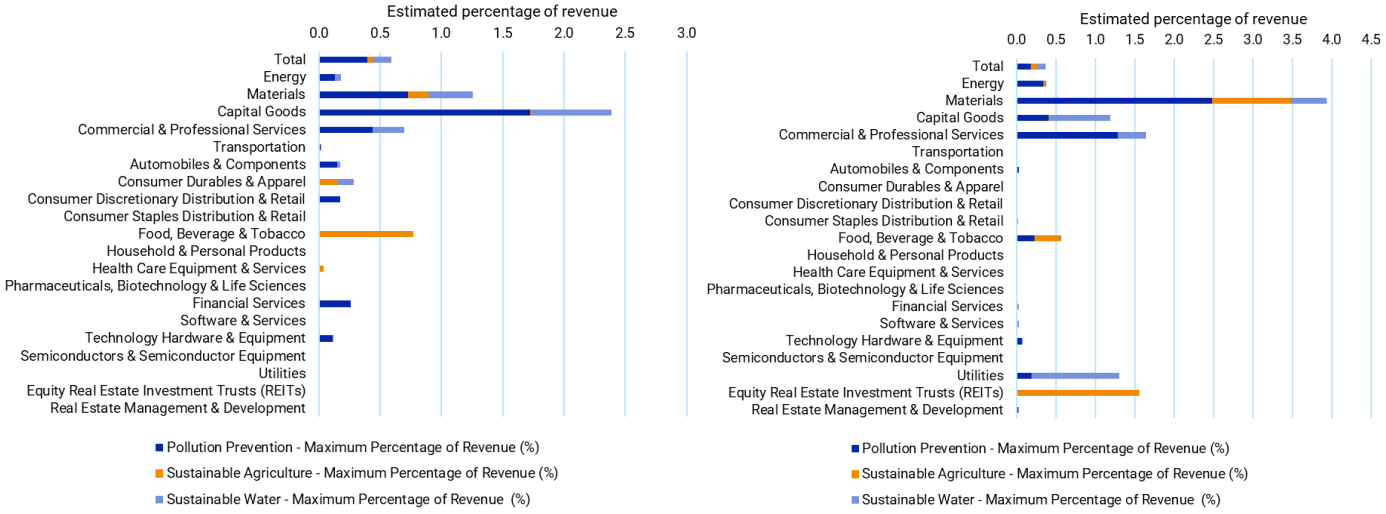
In both the GPIF's domestic equity or foreign equity portfolios, we noticed that the proportion of revenue stemming from such activities was small overall in the listed equities space. Indeed, most of the "biodiversity pure players" may be private companies operating in unlisted markets.

Some industries such as materials and capital goods derived up to 4% of their revenues from those three activities. They were also defined in the above section as "high-risk" industries. Those

industries may feature issuers that are harming nature through some of their processes, products or locations but are also among the largest providers of remedial solutions. These may be considered biodiversity "transition" players in the same way that some fossil fuel businesses are investing massively in renewable energy.

Exhibit 44: Estimated maximum percentage of revenues from businesses connected to nature conservation and biodiversity-loss mitigation per GICS industry group

Domestic equity (left) and foreign equity (right)



Note: in the above charts, we included only GICS industry groups that had more than 0% value in either domestic or foreign equity portfolio. Source: MSCI ESG Research, as of May 2024.

In summary:

While they manifest themselves differently, the biodiversity and climate crises are connected through drivers and impacts. Both present a unique landscape of financial risks and impacts that investors and policymakers are striving to define and address. In many ways, "biodiversity finance" is even more challenging than climate finance in which much analysis stems from carbon budgeting frameworks. Biodiversity data is inherently more complex and multifaceted and requires geospatial analysis.

However, the state of data and models is improving rapidly. Our analysis, which requires combining a heterogeneous data set, shows that some dimensions of risk and impact can be measured, trends can be identified and even some nature-related opportunities can be estimated. When applied to the GPIF portfolios, we spotted a small number of sectors that may represent more acute biodiversity risks through their operational processes, products or locations. These may evolve into financial risks depending on local policy developments, consumer choices or reputation risks. We have not attempted to turn those risk drivers into quantified portfolio impacts — there is no consensus yet on how to transition from nature risks to quantitative financial risks. But this report shows that while such risks, impacts and opportunities are heterogenous and many are just potential, they can become real investment risks and opportunities in the future.

Appendix

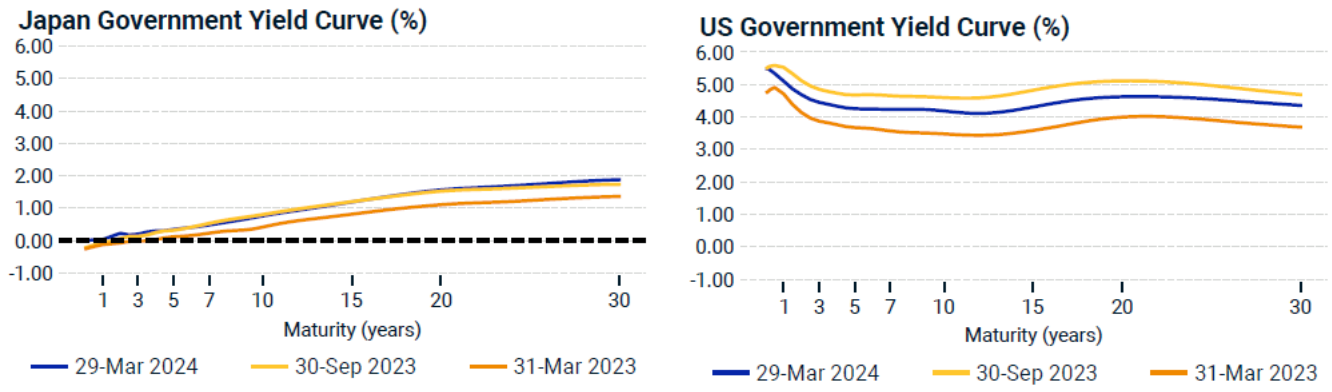
Exhibit 45: Weighted average duration for sovereign bonds (securities in FY2023 excluding newly added ones compared to FY2022 portfolio)

Country	Duration as of FY2023 (end of March 2024)	Duration as of FY2022 (end of March 2023)
Japan	9.69	10.61
U.S.	6.24	7.00
France	7.72	8.51
Italy	6.69	7.38
Germany	8.01	8.84
UK	10.32	10.95
Spain	6.75	7.52
Canada	7.13	7.89
Belgium	8.72	9.48

Note: Country average duration was calculated for GPIF portfolio as weighted average based on market caps, following an assumption that the portfolio solely consists of each country's sovereign bonds.

Source: MSCI ESG Research, as of June 2024.

Exhibit 46: Government nominal yield curves for Japan and U.S.



Source: MSCI, "Daily Fixed-Income Insights," as of Mar. 29, 2024.

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