Report for the Norwegian Ministry of Finance

Modeling Climate Risk and Climate Benchmarks

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Executive summary

Climate change has been recognized widely as a financial risk to investment portfolios. This report studies the emission exposure and climate-risk exposure of Norway's Government Pension Fund Global (GPFG) equity benchmark, using standard methodologies as recommended by the Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) and the Network for Greening the Financial System (NGFS).[1]

Climate risk can be categorized into climate-transition risks and physical climate risks. Climate-transition risk describes risks (and opportunities) that arise from companies' need to adjust their business models to reach "net-zero" emissions. Physical risk describes the potential economic and financial impact from changes in weather conditions, such as increased likelihood of coastal flooding or hurricanes. MSCI's Climate Value-at-Risk (Climate VaR) model estimates both types of risks: Transition risk is modeled by estimating companies' future costs of complying with decarbonization policies as well as potential future revenue from creating green technologies. Physical risks are estimated by projecting into the future changes in weather conditions and their financial impact.

It is important to highlight that climate risk is very different from traditional financial risks such as market risks or credit risks in that there is a very high level of uncertainty to it, both in terms of potential outcomes and related probability distributions. In addition, climate scenarios are typically estimated over long periods of time (up to the year 2100), making accurate estimates challenging. Therefore, climate-related risk simulations should be interpreted with sufficient error margins. The purpose of this report is to take stock of climate-change impact on the global investable equity universe, as well as on the GPFG equity benchmark.

In the Introduction, we explain the report's goal and structure. The report has three main sections, each of which are subdivided into chapters. The first section assesses the climate footprint of the companies in the GPFG equity benchmark; the second section explores the related financial-risk impact of climate change; and the third section investigates the role of climate indexes, including operational issues that investors may face when divesting from emission-intensive companies.

Analysis of carbon footprint and climate transition-risk exposures

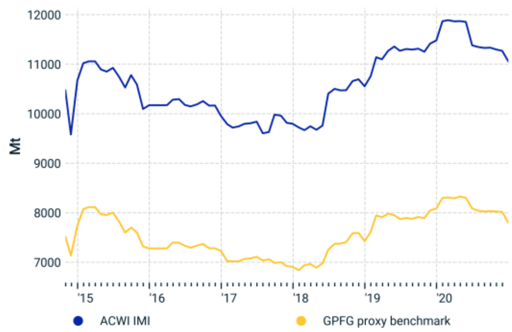
The first section discusses the key climate risk indicators that have been discussed in ongoing policy and regulatory frameworks, such as the TCFD. Chapter 2 in this section looks at the companies in the GPFG equity benchmark's absolute greenhouse gas (GHG) emissions. We found that total emissions (not

[1] The Network for Greening the Financial System (NGFS) is a consortium of 91 central banks and supervisors and 14 observers. NGFS has proposed a set of detailed scenarios that allow different businesses to adopt a coherent and consistent set of tools.

index-weighted) from companies in the GPFG equity benchmark represented 13% of global emissions in 2020.

Emissions in the benchmark have grown over time, similar to the emissions of global equity markets (represented by the MSCI ACWI IMI), except for a pandemic-related dip in emissions in 2020 (Exhibit 1). However, the GPFG equity benchmark's emissions were lower than MSCI ACWI IMI's due to the use of customized exclusions.

Exhibit 1: History of Scope 1 emissions



Data from Oct. 31, 2014, until June 30, 2021. Source: MSCI ESG Research LLC

Emerging markets was the region with the highest level of absolute Scope 1 emissions. Most Scope 1 emissions there were caused by constituents in three sectors: energy, materials and utilities.

The growth of Scope 1 emissions was entirely due to increasing emissions in emerging markets, where the inclusion of China A stocks in the benchmark was the largest contributor. In developed markets, emissions have been trending downward. We also found Scope 1 emissions to be highly concentrated in a small part of the benchmark, especially in energy and utilities stocks from emerging markets. The concentration of Scopes 2 and 3 emissions was slightly lower because the fund models the way in which emissions are distributed along companies' value chains.

While Scope 1 emissions historically have been closely related to the economic growth in emerging markets, it is another question to determine how the carbon intensity of companies' business models have developed. In Chapter 3, we look at the emissions intensity of the GPFG equity proxy benchmark, which relates companies' emissions to their USD sales and is index-weighted. It is a standard measure by which to compare the emissions intensity of different companies or indexes. We observed a decline in the GPFG equity proxy benchmark's emissions intensity, even though absolute emissions were rising. The reason was twofold: First, companies' sales grew. Second, there was a shift in index weights from emission-intensive sectors, such as energy, toward lower-intensity sectors, such as communication services and information technology.

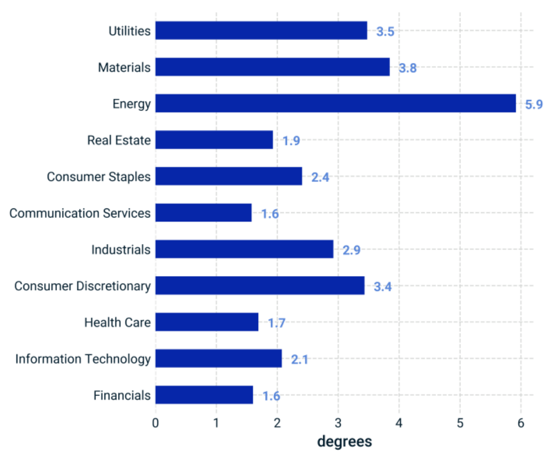
Emission intensities were highest in emerging markets and — looking at sectors — in utilities, energy and materials. As in the previous chapter, we observed very high levels of concentration in emission intensities, especially in Scope 1 intensities. We also observed lower emission-intensity levels in the GPFG equity proxy benchmark than in the MSCI ACWI IMI, mainly due to lower exposure to emerging markets and utilities companies.

Looking at emissions and emission intensities is mainly an analysis of the status quo. To be more forward-looking and to assess companies' alignment with certain temperature targets ("net-zero alignment") we used MSCI's Implied Temperature Rise methodology in Chapter 4, which implements related recommendations by the TCFD. MSCI Implied Temperature Rise measures to what extent companies' projected emissions (taking into account their emission-reduction targets) are aligned or misaligned with a decarbonization pathway that reflects the objectives of the 2015 Paris Agreement of keeping temperature rise well below 2 degrees Celsius (2°C). The closer the alignment, the lower the implied temperature rise.

We found that the aggregated weighted implied temperature rise of the companies in the GPFG equity benchmark was close to the MSCI ACWI IMI's level of 3°C. Emerging markets constituents represented the "hottest" region at 3.8°C, while those from developed markets regions were about 2.9°C. We observed a very skewed distribution of implied temperate rise values across GPFG's equity proxy benchmark, with some companies' temperature rise well exceeding 3°C.

Not surprisingly, the "hottest" sectors were energy, materials and utilities (Exhibit 2), which means that these sectors were not only the most emission-intensive, but also the sectors with the strongest misalignment with the Paris Agreement and thus less likely to stay within their remaining emissions budgets.

Exhibit 2: Implied temperature rise by GICS® sector in the GPFG benchmark



The Global Industry Classification Standard (GICS) was jointly developed by MSCI and S&P Global Market Intelligence. Data as of June 30, 2021. Source: MSCI ESG Research LLC

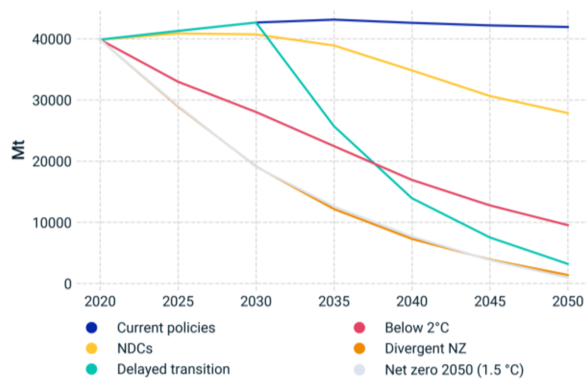
Using a regression analysis, we found that much of the variations in emissions between companies could be explained by size and the sector in which the company operated. Regions were also important, but much less so than sector and size. A similar result was found for emission intensities and implied temperature rise, except that size was not a significant explanatory variable because both these measures are by construction size-adjusted.

Climate scenario analysis

Section II shifts the discussion from climate-risk indicators to scenario analysis and stress-testing approaches. We looked at the projected costs of climate-transition risks and physical risks in GPFG's equity proxy benchmark, using MSCI's Climate VaR methodology, which is closely aligned with TCFD recommendations. Such model analysis can provide important information about companies' climate-risk exposure to different climate scenarios. However, there is a high degree of model uncertainty when estimating future decarbonization costs and physical risks.

In Chapter 5, we summarize the key characteristics of NGFS scenarios, which underpin the climate-scenario simulations in this report. Each scenario assumes a different projected pathway for global emissions and carbon-emission prices (Exhibit 3). The most extreme decarbonization scenario in terms of long-term transition risks is the 2°C delayed-action scenario, in which emissions first increase until 2030, and then (due to late action) an extremely ambitious decarbonization pathway needs to be implemented to limit global warming to 2°C, which (in some countries) even requires negative emissions after 2040, using carbon capture.

Exhibit 3: Future emission pathways of NGFS scenarios

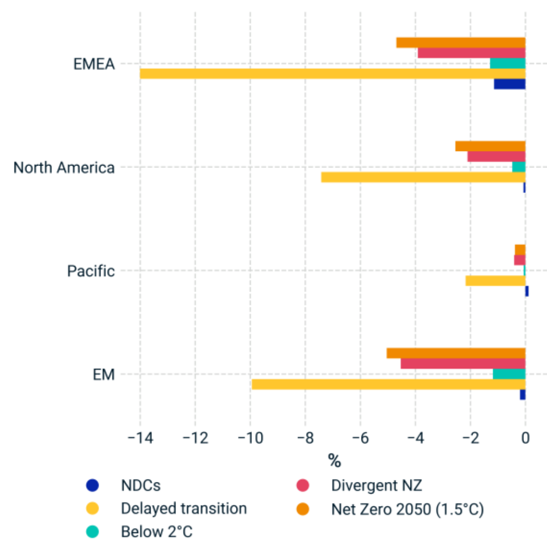


Source: Network for Greening the Financial System

However, the most extreme scenario for physical risks is the business-as-usual (BAU) scenario, in which the world does not decarbonize at all; therefore, very high temperature rise values would be expected after 2050, causing severe projected physical risks.

In Chapter 6, we observed by far the highest transition risk as measured by MSCI's transition Climate VaR for the 2°C delayed-action scenario due to the rapid adjustments warranted by delayed policy action. It is noteworthy that simulated transition risks were higher than physical risks. The highest level of regional transition risk in the GPFG proxy benchmark was found in EMEA for the Delayed Transition scenario, where carbon prices show a tenfold increase by 2050 (Exhibit 4).

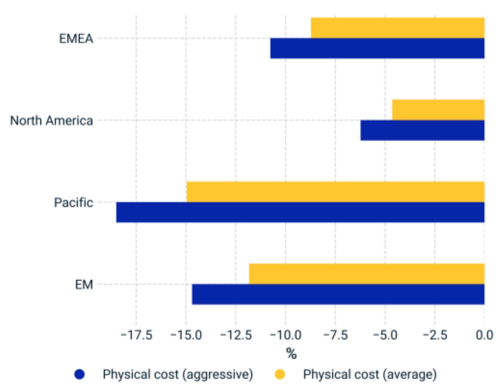
Exhibit 4: Transition costs by region in GPFG proxy benchmark



Data as of June 30, 2021. Source: MSCI ESG Research LLC

With respect to physical risk, the most vulnerable regions represented in the benchmark were Pacific and emerging markets due to higher incidence of extreme heat, coastal flooding and cyclones, among other hazards (Exhibit 5).

Exhibit 5: Physical risks by region in GPFG proxy benchmark



Data as of June 30, 2021. Source: MSCI ESG Research LLC

When looking at transition costs through a sector lens, the energy sector was the most vulnerable, reflecting the challenges of energy companies to align their business models with a net-zero world. By contrast, the most financially impacted sector in terms of physical risk was the utilities sector, due to the high vulnerability of utilities' operations and infrastructure to extreme weather conditions.

Significantly, the concentration of risk clearly decreased with the severity of scenarios, i.e., for the most severe transition and physical risk scenarios the simulated financial impact spread more widely across the benchmark than for less severe scenarios. This finding means that no sector or region should be assumed to be "safe."

Climate benchmarks

Section III looks at the climate-related investment objectives and construction methodologies of different MSCI Climate Indexes and their potential use as benchmarks.

MSCI has developed three categories of climate indexes that implement different investment objectives: decarbonizing the index, shifting capital toward green solutions companies and seeking alignment with net-zero objectives. All MSCI climate index methodologies rely on the various climate metrics that were used in Section I and II of this report.

The report found these climate indexes could lead to less diversification and imply higher index turnover for universal asset owners compared with a broad market benchmark — if companies around the world fail to decarbonize adequately.

In short, if carbon intensity doesn't decline sharply, the investable equity universe may shrink and confront asset owners with a trade-off between financial objectives such as diversification and climate-related objectives.

To probe deeper into this trade-off, we simulated a rules-based decarbonization methodology for GPFG's equity proxy benchmark that decarbonizes by 7% a year by sequentially underweighting the highest emitters by 75% over time. This approach means that exposure to high emitters is sharply reduced but not entirely eliminated.

Simulating this approach based on GPFG's proxy equity benchmark as of 2021, we observed very few trade-offs in the first five to eight years of simulated decarbonization, because emissions were very concentrated in a few emitters.

After 10 years of decarbonization, index turnover and tracking error increased while diversification decreased. At some point, further decarbonization was no longer possible without excluding certain stocks, which means the trade-off between decarbonization and turnover and diversification became even more stark. This shows that the use of a climate benchmark to pursue a climate-related objective may have an impact on the financial characteristics of the index in the long run. However, in a world in which the underlying benchmark itself decarbonizes at the desired rate, investors face no practical trade-offs. Moreover, large asset owners may also pursue engagement strategies to lower carbon emissions for the entire universe.

Introduction

Climate change is a great challenge for humankind, and its consequences are already apparent. The effects of climate change are intergenerational and macro-critical, which potentially could have huge implications for the stability of economic and financial systems (Andersson et al., 2020; IMF, 2019).

Fundamentally, climate change stems from excessive GHG emissions. Not only does climate change jeopardize the planet's long-term welfare but it inflicts costs on society as a whole while benefitting carbon emitters. Another type of cost transfer, referred to as a climate externality, is technology spillovers, where firms invest their private capital and labor to develop innovative carbon-neutral technologies but the benefits will accrue to the wider business community (Stock, 2020). To address market failures arising from such externalities and internalize any costs, various international agencies have argued that some form of government intervention is needed (Andersson et al., 2020; World Bank, 2019).

One solution to address this externality is putting a price on carbon emissions, which can then form the basis of various regulatory policies. Global efforts led by the International Monetary Fund (IMF) have urged governments to introduce carbon taxes that can internalize climate externalities. Higher implicit costs of producing carbon-intensive goods and services may drive companies to employ green technologies. National governments could use revenue from such policies to fund public green investments, reduce fiscal deficits and redistribute governmental spending through greater expenditure on public services and a reduction in payroll taxes (IMF, 2019; Krogstrup and Oman, 2019). While carbon taxes are argued to be the most efficient solution, other potentially less efficient tools could include Emission Trading Systems (ETS) and revenue-neutral "feebates," a varying fee charged to firms based on their emissions intensity being below or above average (IMF, 2019).[2]

Another argument for government intervention is the potential co-benefits of mitigating climate change in the form of lower health-care costs and a sustainable economic growth rate from the green revolution that is better captured as the "social value of mitigation action," as documented by various policy reports (Hourcade et al., 2018; UNFCCC 2016).

[2] ETS are said to be less efficient because carbon prices in them tend to be uncertain and ETS revenue for the government may be lower because of the administrative burden of allocating free allowances and using revenue for future auctions (IMF, 2019).

The watershed moment when governments took a first step toward addressing climate externality was the 2015 Paris Agreement, where more than 190 countries adopted the goal of limiting the increase in global average temperatures to well below 2°C above preindustrial levels.[3]

Efforts to achieve the Paris Agreement goal are now widely referred to as "net-zero," a scenario in which no more greenhouse gas emissions enter the atmosphere than are removed. The net-zero transition will require capital reallocation of USD 12 trillion to USD 20 trillion over the next two decades (IMF, 2021).

More recently, 151 countries submitted new climate action plans at the United Nations Climate Change Conference (known as COP26) in Glasgow. The conference led to the Glasgow Climate Pact, through which new national commitments may limit the temperature rise to 2.5°C as compared with the 4°C warming potential before the 2015 Paris Agreement (World Resources Institute, 2021). The pact also urges countries to lower methane emissions by 30%, reduce use of coal as an energy source and phase out fossil-fuel subsidies.

To limit global warming well below 2°C, reaching net-zero emissions in the long run is not sufficient. Greenhouse gases accumulate in the atmosphere, so there is a limit to how much we can emit along the journey to net-zero: The Intergovernmental Panel on Climate Change (IPCC) has estimated the world's remaining "emissions budget" to be cumulative emissions of 400 gigatons (Gt) of CO2 to limit warming to 1.5°C and 1,150 Gt of cumulative CO2 emissions to limit warming to 2°C, with a 67% confidence level (with budgets starting as of Jan. 1, 2020).[4]

To achieve this objective, countries collectively defined a national emission-reduction path — called Nationally Determined Contributions, or NDCs — which ultimately will be mapped onto different sectors and onto individual companies.

While governments have played the key role in defining the political objectives for tackling climate change and their related NDCs, the private sector has an increasingly important role to play in upholding the Glasgow Climate Pact. Many corporations will have to adjust their operations and/or their products and services to meet their countries' NDCs and future climate policies. Some companies, such as BP, Ford Motor and CEMEX, already have set ambitious net-zero goals.

However, many companies will require capital to change their business models. Nearly 70% of total investments required for the transition to net-zero emissions can

[3] The IPCC Special Report on Global Warming of 1.5°C uses the reference period 1850-1900 to represent preindustrial temperature. See the "Frequently Asked Questions" section of the report.

[4] "Climate Change 2021: The Physical Science Basis." 2021. Intergovernmental Panel on Climate Change.

be fulfilled by the investment community, according to a 2021 report produced by the United Nations Framework Convention on Climate Change (UNFCC) Race to Zero campaign. Financial institutions also can take a more active role in engaging with corporations to help them meet net-zero emissions targets and support innovation by investing in the clean-tech sector.

A key impediment to the efficient allocation of private capital toward climate-change mitigation and adaptation has been the lack of robust climate information architecture (Financial Reporting Council, 2020). Various international frameworks and policy forums have been developed — such as the Financial Stability Board's Task Force on Climate-related Disclosures (TCFD), the EU's Taxonomy Regulation and the Network for Greening the Financial System — to create common standards and guidelines for investors to manage the transition in their capital allocation and risk-management frameworks with respect to climate change.

Decarbonizing the global economy successfully will require an unprecedented level of cooperation between countries. However, various international institutions note that the political economy also could drive a wedge between climate aspirations and realistic targets (Krogstrup and Oman, 2019; Battaglini and Harstad, 2016). For instance, national governments may be reluctant to tax carbon emissions because they may be more focused on domestic politics. Other frictions could materialize due to lack of coordination between different governments, which may give rise to disorderly transition scenarios.

However, tackling a systemic issue like climate change requires strong cooperation between the three "economic key players": companies, investors and governments. Both listed and privately held companies face transitioning their business models while investors can support this transition by providing capital. Governments have a key role to play in tackling the problem of externalities: Historically, emitting GHG was "free" and the damaging effect on the ecosystem was not charged back to the polluting entities. Tackling this "free-rider" problem through a change in the governance framework is the main role governments can play.

In this report, we focus on the role of investors and how climate change may affect the financial risk profile of global equity benchmarks. Before discussing how to measure and manage climate risks, it is important to define the terms climate-transition risk and physical risk.

Climate-transition risk has two components: policy risk and opportunities from green technology. Policy risk measures the adjustment costs to companies to decarbonize their business. In our analysis, this risk is largely driven by corporate emissions and the projected price of GHG emissions in a given climate scenario.

In MSCI's Climate Value-at-Risk (Climate VaR) model, green technology may generate revenue by providing technology to high-emitting companies that seek to decarbonize their existing business operations. To attribute potential future green revenue to individual companies, we use the concept of green patents in MSCI's Climate VaR methodology. MSCI's methodology does not include the allocation of green revenue from governments' carbon taxes.

Physical risks are potential future financial losses from physical damage to companies' production sites or interruption of product processes by extreme weather conditions, such as droughts, coastal flooding, etc.

For all three risk categories, we will define the financial risk or opportunity faced by investors as the discounted future unexpected costs or revenue. We use various climate benchmarks as proxies for the investable universe.

It is also important to emphasize that climate change is very different from traditional financial risks such as market risk or credit risk. Unlike credit markets, climate change may be difficult to price because the risks may be uncertain. In his seminal book *Risk, Uncertainty, and Profit*, University of Chicago economist Frank H. Knight explained that *risk* is present when the set of potential future events is known and occurs with measurable probability; *uncertainty* is present when the complete set or likelihood of future events is indefinite or incalculable (Knight, 1921).

While efficient markets can be expected to price risk efficiently, the same may not hold for uncertainty due to unknown probabilities of future events or incomplete knowledge about the set of future states of the economic system.

Climate change is largely referred to as a "risk" in the public debate. In reality, it is largely governed by "uncertainty," as scientific estimates for the probability distribution of future climate temperature scenarios and related parameters such as the price of carbon emissions may vary widely.

This difference has two important implications for our analysis: First, measuring climate risks using probability functions as used in market or credit risk is not possible. Instead, we will follow the recommendations of the TCFD and use scenario analysis, which simulates the financial impact of certain climate scenarios on asset prices without trying to estimate the probability of the scenario happening. Second, we need to interpret all climate- and risk-related results understanding that there are considerable margins of error in all estimated results. This is especially the case for climate scenarios that project future emissions and economic developments up to the year 2100.

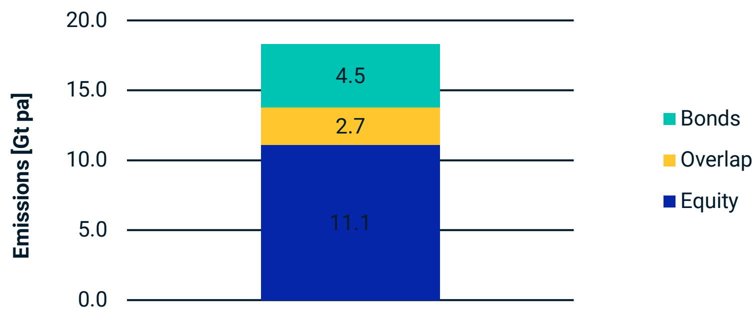
In practice, this means that we can assume that everything that is known about climate change today or can be anticipated with reasonable likelihood may be priced in by markets (referred to as “expected financial impact”). However, what really matters for our analysis is the *unexpected financial impact* — i.e., any potential pre-pricing of assets that markets cannot foresee today due to the high level of uncertainty. Important insights can be gained by understanding key developments in climate exposures within the GPFG benchmark and stress-testing the benchmark against different climate-transition scenarios. This is the objective of MSCI’s Climate VaR methodology.

In this report, we will focus on an analysis of climate risk in equity markets for two reasons: First, equity investments make up the largest part of GPFG’s investments (about 70% versus about 25% in fixed-income securities and 5% in real estate). Second, history for climate data as well as climate stress-testing tools is more readily available for equities. In fixed income, emission data and climate-risk analysis were available for corporate bonds, but comparing emission data and risk data to sovereign bonds can be challenging.

Comparing Scope 1 and scope 2 emissions in listed equity markets (as represented by MSCI ACWI IMI) and corporate bond markets (the universe of MSCI corporate bond indexes), we see that total emissions in the equity universe were higher and there was a significant overlap in emissions between both asset classes (Exhibit 6).[5] Given the relative weighting of equities and fixed income securities in GPFG’s portfolio, we can assume that the fund’s climate-risk profile is largely driven by equity investments.

[5] These indexes include global developed-market IG and HY fixed-coupon corporate-bond issues rated by S&P/Moody’s and issued in USD or EUR, which fulfill certain predefined criteria such as size, maturity and credit ratings.

Exhibit 6: Total Scope 1 and 2 emissions of MSCI ACWI IMI and MSCI Corporate Bond Index constituents



Data as of June 30, 2021. Source: MSCI ESG Research LLC

OUTLINE OF THE REPORT

This report examines GPFG's climate-risk exposure from various angles, using emission and climate-risk methodologies aligned with industry standards and the recommendations of industry organizations. For instance, we measure absolute GHG emissions in tons CO2 equivalent, categorized in Scope 1, 2 and 3 emissions, as defined by the Greenhouse Gas Protocol. In addition, emission intensities are a common measure used to compare the carbon intensity of companies in a financial index and is aligned with recommendations by the TCFD. The calculation of climate-stress scenarios and implied temperature rise also follow TCFD recommendations.

To start, Section 1 of this report focuses on three climate metrics that the TCFD recommends that investors disclose:

1. Absolute GHG emissions that are the actual drivers of global warming (Chapter 2).
2. Emissions intensities, a standard approach to measuring how emission-intensive companies' business models are (Chapter 3). We use the concept of weighted-average emission intensities to compare the climate-risk profile of indexes. However, emissions are mainly a measure of the status quo.
3. Implied temperature rise provides a more forward-looking assessment of listed companies' alignment or misalignment with the decarbonization pathways required to limit global warming to well below 2°C (Chapter 4).

Section 2 of the report addresses the concern that climate change is complex and uncertain by exploring scenario analysis. Chapter 5 looks at the different emission scenarios proposed by the NGFS and discusses the evolution of GPFG's emissions under each scenario. This chapter also discusses the inherent uncertainty in estimating carbon emission prices that results from model uncertainty in predicting the evolution of various socioeconomic variables, among other factors. Chapter 6 discusses estimates of companies' transition costs and potential costs due to the appearance of physical climate risks in GPFG's equity benchmark and the market benchmark (MSCI ACWI IMI). These estimates are based on MSCI's Climate Value-at-Risk methodology.

Finally, Section 3 of the report investigates the role of climate indexes and highlights some of the operational issues that investors may face when adopting commonly argued strategies of divestment from emission-intensive companies. Chapter 7 looks at different MSCI climate-index methodologies in terms of how they address climate risks and opportunities and their financial profiles, i.e., diversification, tracking error and turnover. Chapter 8 analyzes some customized decarbonization simulations to probe deeper into these trade-offs.

The conclusion, in Chapter 9, summarizes the key findings of the report.

BENCHMARK DEFINITIONS USED IN THIS REPORT

In this report, we use standard MSCI indexes to define the global equity opportunity set as well as the universe of regions and sectors that we look at in our analysis. It is important to understand the following definitions used throughout all sections of this report:

- MSCI classifies countries as **developed**, **emerging** and **frontier** markets, based on criteria for countries' economic development, the size of the capital market, and the liquidity and accessibility of the local stock market.
- The **total market capitalization** of a stock is its price times the number of outstanding shares.
- The **free-float-adjusted market capitalization** of a stock is the part of total market capitalization that excludes closely held shares. It is calculated by multiplying the total market capitalization of a stock by the foreign inclusion factor (which measures the proportion of shares available to foreign investors).
- **MSCI ACWI IMI total market cap** is a market-capitalization-weighted index that targets 99% market coverage of developed and emerging markets and includes large caps, midcaps and small caps. It is not free-float-adjusted.
- **MSCI ACWI IMI** is a free-float adjusted market-capitalization-weighted index that targets 99% market coverage of developed and emerging markets and includes large caps, midcaps and small caps. It is broken down into developed markets (**MSCI World IMI**) and emerging markets (**MSCI Emerging Markets IMI**). MSCI

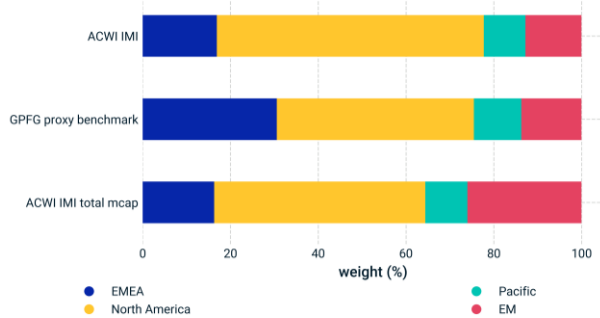
World IMI can be broken down into three regions: **MSCI North America IMI**, **MSCI EMEA IMI** (Europe and Middle East) and **MSCI Pacific IMI**. All these regional indexes are free-float-adjusted.

- **MSCI ACWI** is a free-float-adjusted market-capitalization-weighted index that targets 85% market coverage of developed and emerging markets and includes large caps and midcaps (but no small caps). It is broken down into developed markets (**MSCI World**) and emerging markets (**MSCI Emerging Markets**). MSCI World can be broken down into **MSCI North America**, **MSCI EMEA** and **MSCI Pacific**. All these regional indexes are free-float-adjusted.
- In this report we use MSCI World IMI and MSCI World as a representative of developed markets' equity opportunity set and MSCI Emerging Markets IMI and MSCI Emerging Markets as a representation of emerging markets' equity opportunity set. We frequently abbreviate developed markets as **DM** and emerging markets as **EM**. For instance, **MSCI EM** is an abbreviation for MSCI Emerging Markets.
- **GPFG's proxy equity benchmark** is an index MSCI calculated as a proxy for GPFG's current equity benchmark. It uses MSCI ACWI IMI as starting point, applies GPFG's regional scaling factors for North America, EMEA, Pacific and emerging markets, excludes Saudi Arabia, Argentina and Norway and applies a customized list of exclusions from the GPFG investment universe.

All index returns are calculated in USD, unless explicitly stated otherwise.

Exhibits 7 and 8 show a comparison of sector weights and regional weights of MSCI ACWI IMI and MSCI ACWI IMI total market cap versus the GPFG proxy equity benchmark.

Exhibit 7: Comparison of regional weights

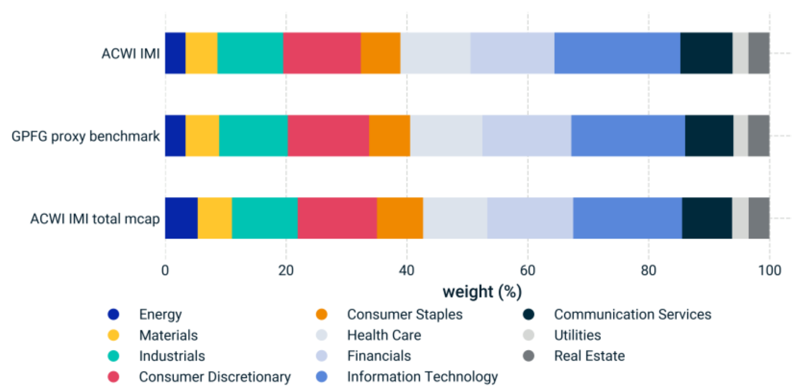


Data as of June 30, 2021. Source: MSCI ESG Research LLC

The main difference between the GPFG proxy equity benchmark and the ACWI IMI was the former's much higher weighting in EMEA and a lower weighting in North American equities. The MSCI ACWI IMI's total market cap had a much higher weight in emerging markets because the average free-float in emerging markets was lower than in developed markets.

In terms of sector weights, the GPFG proxy equity benchmark showed a much lower weighting in information technology and consumer services due to its relative underweighting in North America. On the other hand, consumer discretionary and consumer staples were relatively overweight.

Exhibit 8: Comparison of sector weights



Data as of June 30, 2021. Source: MSCI ESG Research LLC

CLIMATE DATA AND DEFINITIONS USED IN THIS REPORT

Descriptor	Definition
Carbon intensity	The amount of Scope 1 and 2 GHG (direct emissions and electricity use) in tons of CO2-equivalent (tCO2e) per USD 1 million of sales.
Scope 3 carbon intensity	The amount of Scope 3 GHG emissions in tCO2e per USD 1 million sales, based on MSCI's Scope 3 estimation model, generated by a company's supply chain. This covers all 15 categories of upstream and downstream Scope 3 emissions, as defined by the Greenhouse Gas Protocol. Details on the methodology can be found in Hadjikyriakou et al. (2020).
Fossil-fuel reserves	Potential GHG emissions in million tCO2e embedded in companies' coal, oil and gas reserves per USD 1 million market capitalization.
Green revenue share	The share (in percent) of a company's revenue derived from alternative energy, energy efficiency and green building.
Low Carbon Transition Score (LCT Score)	A measure of a company's climate transition risk arrived at by aggregating Scope 1, 2 and 3 emissions, avoided emissions and the quality of companies' climate management into a score between 0 (highest-risk) and 10 (lowest-risk/highest-opportunity).
Low Carbon Transition Category (LCT Category)	A category assigned to a company that highlights the predominant transition risks and opportunities the company is most likely to face. The LCT category is based on the LCT Score. There are five LCT categories: stranded assets, product transition, operation transition, neutral and solutions. Details can be found in Badani et al. (2019).
Implied Temperature Rise (ITR)	A measure that converts a company's current and projected greenhouse gas emissions across all emissions scopes (based on the company's track record and stated reduction targets) to an estimated rise in global temperatures by comparing those emissions with the company's emission budget for keeping warming this century well below 2°C.
Climate Value-at-Risk (Climate VaR)	Forward-looking scenario-based analysis of companies' transition risk and physical risk as % of current market capitalization. MSCI calculates companies' Climate VaR for 3°C, 2°C and 1.5°C warming scenarios. A company's total Climate VaR is the sum of three sub-components: 1. **Policy Climate VaR:** estimating the business impact of decarbonization 2. **Technology Climate VaR:** estimating financial opportunities from climate solutions technology 3. **Physical Climate VaR:** estimating companies' future cost from physical risk.

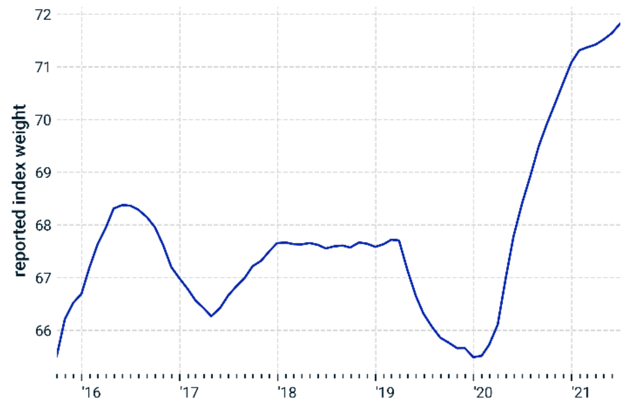
Section I: Analysis of carbon footprint and climate transition-risk exposures

In this section, we look at the climate profile of global listed equity markets and the GPFG proxy equity benchmark, using three metrics recommended by the TCFD: companies' absolute emissions, companies' emission intensities and implied temperature rise. These measures are all based on companies' emissions and remaining emission budgets and can be considered proxies for companies' climate transition-risk exposure because they indicate the challenges companies may face in decarbonizing their business models.

Global regulatory efforts have focused on improving the climate data architecture through more-informative climate disclosure practices, such as the introduction of the Financial Stability Board's TCFD and the EU's Corporate Sustainability Reporting Directive (CSRD). The ultimate objective of these standards is to provide more relevant and informative disclosures that would help investors price climate risk in their investment decisions and asset allocations.

When it comes to reporting emissions disclosures, firms have generally adopted the standards developed by Greenhouse Gas Protocol (2015). According to this reporting standard, firms can classify their emissions into three scopes: Scopes 1, 2 and 3. Scope 1 and 2 emissions are from company-owned sources and from the generation of purchased energy, respectively. Scope 3 emissions include all indirect emissions that occur in the value chain of the company. Exhibit 9 looks at the historical development of companies' disclosure of Scopes 1 and 2 emissions in the GPFG equity proxy benchmark.

Exhibit 9: Weight of companies in GPFG proxy benchmark that disclose Scope 1 and 2 emissions

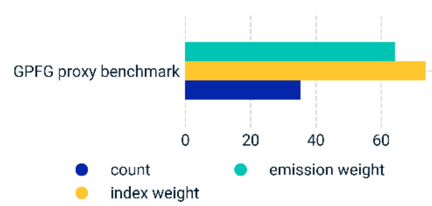


Data from Oct. 31, 2014, to June 30, 2021. Rolling 12-month average. Source: MSCI ESG Research LLC

We have seen a trend toward increased emissions disclosure, especially in 2020 and 2021. There are multiple drivers that may explain this: increasing public awareness of climate change and pressure from investors who want to know the GHG footprint of their investments, regulatory pressure and recommendations from industry organizations such as the TCFD.

Exhibit 10 probes deeper into the link between climate disclosure and company size. It is interesting to note that while only about one-third of companies in the benchmark disclosed their emissions, these companies accounted for over 60% of emissions and over 70% of index weights. This means that larger companies and large emitters were on average more likely to disclose their emissions.

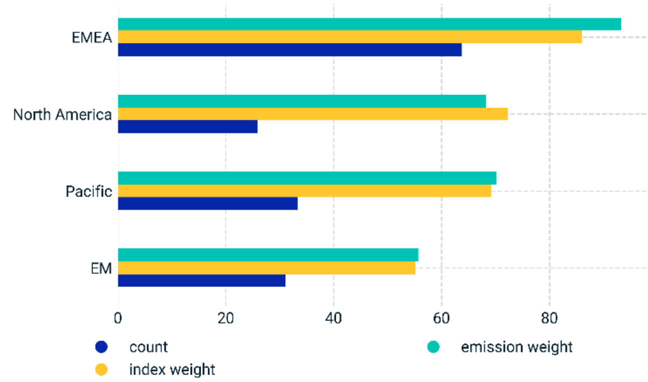
Exhibit 10: Percentage of Scope 1 and 2 reporting companies



Data as of June 30, 2021. Source: MSCI ESG Research LLC

However, there were clear differences in emissions disclosures by region, as shown in Exhibit 11. Disclosure levels in developed markets were clearly higher than in emerging markets, and within developed markets, EMEA had by far the highest percentage of reporting companies.

Exhibit 11: Percentage of Scope 1 and 2 reporting companies in GPFG proxy benchmark



Data as of June 30, 2021. Source: MSCI ESG Research LLC

MSCI uses industry-specific emissions estimation models for companies that do not report emissions.

Analysis of real-world emissions

Looking at companies' absolute Scope 1 emissions is a natural starting point for our analysis because these are the actual drivers of climate change: The more GHG is emitted into the atmosphere, the more global warming we expect in the future.

However, absolute company emissions are also an important indicator of how companies may be exposed to climate-transition risk (TCFD, 2021b). *All else remaining the same*, more absolute emissions would imply greater vulnerability to climate risk.

When it comes to analyzing real-world GHG emissions, we initially focus only on Scope 1 emissions to avoid double-counting emissions across different scopes. We measure GHG emissions in tons of CO2-equivalent ("CO2e") emissions to account for differences in the effective warming potential of different types of greenhouse gas emissions, which has become an industry standard. In subsequent sections, we will look at Scope 2 to analyze companies' use of electricity and 3 emissions to analyze companies' upstream and downstream involvement in the fossil-fuel value chain. The calculation of Scope 1, 2 and 3 emissions is based on the definitions in the GHG Protocol (2015)

Overview MSCI Scope 1, 2 and 3 GHG emission estimation models

Scopes 1 and 2: MSCI ESG Research estimates companies' Scope 1 and 2 emissions when not reported. For firms involved in power generation, MSCI ESG Research starts by estimating direct emissions due to power generation using power generation fuel mix data to estimate Scope 1 emissions. For firms not involved in power generation, we calculate emissions intensity based on the company's previously reported emissions (if available). This approach is based on the argument that emission intensities reflect the specifics of the businesses and geographies in which the company operates and its own production processes. Emissions intensity is multiplied by revenue for that year to estimate emissions. If no prior emissions data exists, we use the industry-segment-specific intensity, which is based on estimated carbon intensities for more than 1,000 industry segments. Specifically, we calculate average intensities (adjusted for potential outliers) in each of the companies' reported industry segments for the year in question and weight it by the relevant segment's revenue.

Scope 3: MSCI ESG Research uses the publicly available Greenhouse Gas Protocol (GHGP) framework for Scope 3 emissions accounting. It consists of 15 different upstream and downstream categories. This serves as the conceptual basis for our estimation modeling. Because each category has its own idiosyncrasies that can influence carbon emissions, we adopt individual models for every category that allows us to gather emission estimates per category, in contrast to a simple aggregation to upstream and downstream emissions. It further allows drilling down to the drivers of Scope 3 emissions across the value chain. MSCI ESG Research follows a bottom-up approach that uses company-specific information (e.g., detailed production data) to estimate Scope 3 emissions. If this is not available, we make use of sectoral revenue and emission intensities to estimate a category's emissions. This is more commonly referred to as the top-down approach under the GHGP framework.

For more detailed explanation of the scope estimation methodologies, please refer to Hadjikyriakou et al. (2020).

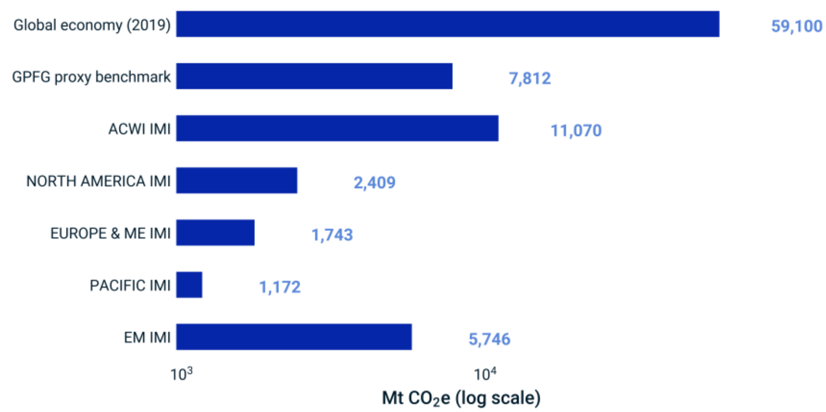
DEVELOPMENT OF EMISSIONS

Exhibit 12 compares the world's GHG emissions to the emissions of companies in the MSCI ACWI IMI (including regions) and the GPFG proxy benchmark.

MSCI ACWI IMI constituents accounted for about one-fifth of global emissions. This means that about four-fifths of the world's emissions were caused not by listed companies but rather other sources, such as agriculture (which is mainly not listed), government-owned businesses, private companies, public transportation, etc. Within the MSCI ACWI IMI, emerging markets accounted for about half of the benchmark's emissions. This compares with EM's weight of only 13% in the benchmark as of June 30, 2021, showing that EM was more carbon-intensive than DM. Note: In emerging markets, a relatively smaller part of the economy is represented by listed companies than in developed markets.

The emissions of the constituents in the GFPG proxy benchmark were below the MSCI ACWI IMI due to the exclusion of carbon-intensive businesses in the latter.

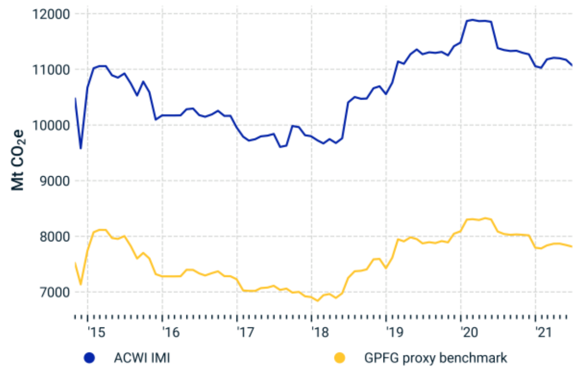
Exhibit 12: Comparison of Scope 1 emissions



Data as of June 30, 2021. Source: Global emissions are based on UNEP 2019; emissions of Norway (excluding forestry) are from climateactiontracker.org; MSCI ESG Research LLC

Exhibit 13 looks at the history of Scope 1 emissions in the MSCI ACWI IMI and the GPFG proxy benchmark. While GPFG's emissions were consistently lower than MSCI ACWI IMI's, they followed a similar trend: Emissions clearly increased in 2018 due to the inclusion of China A stocks in the benchmark, while we saw a decline in 2020 due to the COVID-19 impact on business activity. Note that within the 50 countries included in the ACWI IMI benchmark, only five did not define a nationally determined contribution to the reduction of carbon emissions (Saudi Arabia, Kuwait, Qatar, United Arab Emirates and Egypt). These countries accounted for 0.6% of the weight in the MSCI ACWI IMI and 0.3% of weight in the GPFG proxy benchmark as of June 30, 2021.

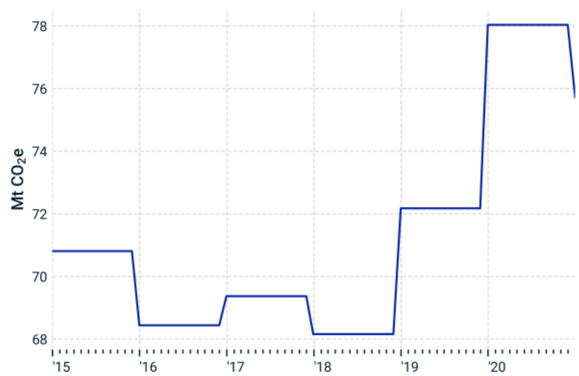
Exhibit 13: History of Scope 1 emissions



Data from Oct. 31, 2014, to June 30, 2021. Source: MSCI ESG Research LLC

Another way to calculating carbon emissions is using the equity ownership approach, as postulated by the TCFD's recommendation report (2017b). Under this approach, carbon emissions are allocated to investors based on their ownership of a benchmark's constituents. For instance, GPFG owns over 1% of the total market capitalization (not free-float-adjusted) of companies in the GPFG equity proxy benchmark (Exhibit 14), which corresponds to about 76Mt in CO2e emissions.

Exhibit 14: Emissions owned by GPFG



Data from Oct. 31, 2014, to June 30, 2021. Source: year-end fund sizes published by NBIM (nbim.no)

POTENTIAL EMISSIONS

In addition to company emissions, we looked at' potential emissions inherent in company fossil-fuel reserves. These reserves may turn into stranded assets and therefore may be an important aspect of investors' risk assessment. Scientists have estimated that 90% of coal and 60% of oil and fossil methane gas will have to remain unused to limit global warming to below 1.5°C relative to preindustrial levels (Welsby et al., 2021).

Potential emissions in the MSCI ACWI IMI accounted for over 40 times the benchmark's annual Scope 1 emissions, indicating how significant these reserves are in relation to companies' annual emissions (Exhibit 15). We observed an increase of about 100 Gt in potential emissions in 2019 due to the inclusion of Saudi Aramco in the MSCI ACWI IMI. However, potential emissions in the GPFG proxy benchmark were lower due to its customized exclusion list and because GPFG's benchmark did not include companies from Saudi Arabia.

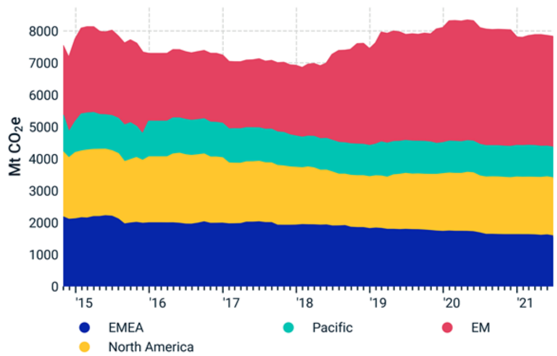
Exhibit 15: History of potential emissions

Data from June 30, 2016, to June 30, 2021. Source: MSCI ESG Research LLC

EMISSIONS BY REGION

Looking at the history of regional Scope 1 emissions in the GPFG proxy benchmark (Exhibit 16), we observed that emissions were declining slightly in DM, but clearly increasing in EM. Within EM, Asia was the largest contributor to both absolute Scope 1 emissions and because of the partial inclusion of China A stocks in 2018, which has grown over time.

Exhibit 16: Regional Scope 1 emissions for the GPFG proxy benchmark

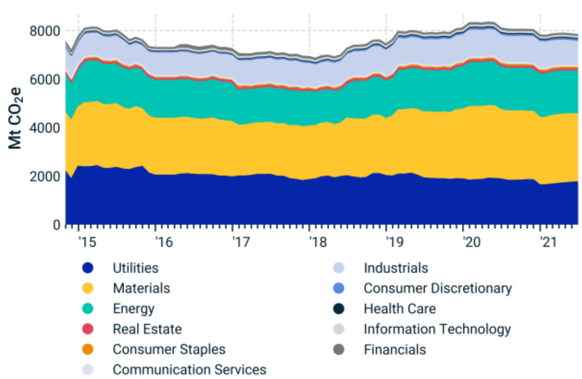


Data from Oct. 31, 2014, to June 30, 2021. Source: MSCI ESG Research LLC

EMISSIONS BY SECTOR

Exhibit 17 looks at the historical development of GPFG's Scope 1 emissions across 11 GICS sectors.

Exhibit 17: Sector Scope 1 emissions for GPFG proxy benchmark



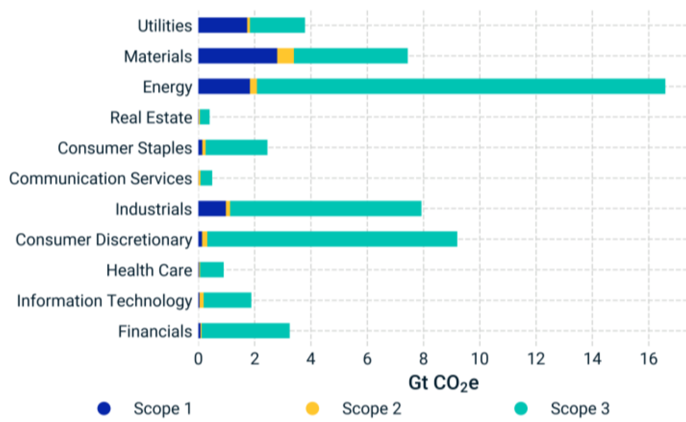
Data from Oct. 31, 2014, to June 30, 2021. Source: MSCI ESG Research LLC

Among the most emission-intensive sectors, utilities showed a decline in emissions while the materials sector experienced increased emissions over our study period. The decline in emissions in the utilities sector reflects the increasing use of renewable energy sources.

TOTAL BENCHMARK EMISSIONS

While looking at Scope 1 emissions is a good indicator for the actual emissions of companies without double-counting, it neglects the involvement of companies in the fossil-value chain, as measured by their Scope 2 and 3 emissions. Assessing exposure to total emissions is important because firms with low Scope 1 emissions may still be sensitive to climate risks due to their exposure to carbon-intensive firms in their value chains. In this subsection, we focus on total benchmark emissions to provide a holistic view of GPFG's emissions. It is important to highlight that because companies share their value chain with multiple other companies, double-counting is unavoidable when estimating Scope 2 and 3 emissions. The main area of double-counting is Scope 3 emissions, where MSCI ESG Research estimates that due to the overlap in companies supply chains, Scope 3 emissions are (on average) double-counted about 4.6 times.

Exhibit 18: Scope 1, 2 and 3 emissions for GPFG proxy benchmark



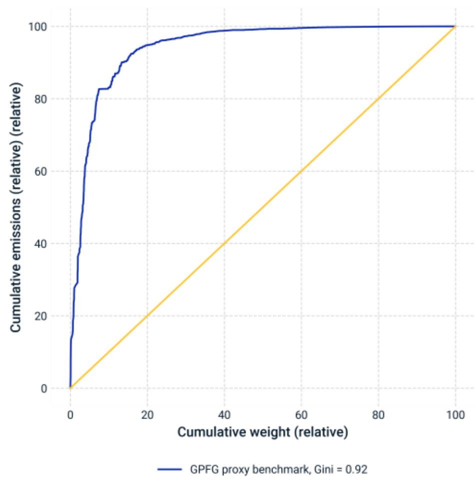
Data as of June 30, 2021. Source: MSCI ESG Research LLC

The energy sector had by far the highest amount of Scope 3 emissions due to its reliance on fossil fuels. However, it is important to mention that even sectors that have relatively low Scope 1 and 2 emissions showed large Scope 3 emissions, e.g., the industrials or consumer discretionary sectors, due to their supply chains. Focusing solely on high Scope 1 and 2 emitting sectors (utilities, materials and energy) is too simplistic a view and neglects the complexities of modern supply chains.

CONCENTRATION OF EMISSIONS

Scope 1 emissions may vary considerably across the constituents in a benchmark due to differences in company size and sector. These differences can affect how concentrated emissions are across benchmark constituents. We can illustrate the level of concentration by using a Lorenz curve, which sorts companies in decreasing order of emissions and plots their cumulative emissions versus companies' cumulative index weights. A straight line would indicate an index with uniform emissions across all companies, while a curved lined indicates concentration. Exhibit 19 shows a very high concentration of Scope 1 emissions within the GPFG proxy benchmark: The 10% largest emitters caused close to 90% of total emissions in the GPFG proxy benchmark. This is also reflected in the relatively high Gini coefficient of 0.92.

Exhibit 19: Lorenz curve of companies' Scope 1 emissions in GPFG proxy benchmark



Data as of June 30, 2021. Source: MSCI ESG Research LLC

Exhibit 20 looks at the largest emitters in the benchmark, which were all in the energy, materials and utilities sectors. The largest global emitter in the GPFG proxy benchmark — Gazprom PAO — comprised 3% of the benchmark's Scope 1 emissions.

Exhibit 20: Largest Scope 1 emitters in GPFG proxy benchmark

	Emissions (Mt)	Cumulative emissions (% of GPFG proxy)	Country	GICS sector
GAZPROM PAO	240.0	3.0	RUSSIA	Energy
ARCELORMITTAL SA	173.6	5.1	FRANCE	Materials
GD POWER DEVELOPMENT CO LTD	147.3	7.0	CHINA	Utilities
ANHUI CONCH CEMENT CO LTD	146.0	8.8	CHINA	Materials
PETROCHINA CO LTD	129.2	10.4	CHINA	Energy
CHINA PETROLEUM & CHEMICAL CORP	125.7	11.9	CHINA	Energy
LAFARGEHOLCIM	121.0	13.4	SWITZERLAND	Materials
EXXON MOBIL CORPORATION	116.0	14.9	USA	Energy
SOUTHERN CO	102.2	16.1	USA	Utilities
CHINA NATIONAL BUILDING MATERIAL CO	101.2	17.4	CHINA	Materials
NIPPON STEEL CORPORATION	95.2	18.6	JAPAN	Materials
ENEL SPA	94.8	19.8	ITALY	Utilities
TOKYO ELECTRIC POWER COMPANY HLDS INC	82.0	20.8	JAPAN	Utilities
INTER RAO YEES PAO	81.3	21.8	RUSSIA	Utilities
VISTRA ENERGY CORP	78.9	22.8	USA	Utilities
HEIDELBERGCEMENT AG	76.7	23.7	GERMANY	Materials
ROYAL DUTCH SHELL PLC	70.0	24.6	UNITED KINGDOM	Energy
CHINA HONGQIAO	66.6	25.4	CHINA	Materials
BBMG CORP	62.8	26.2	CHINA	Materials
PETROLEO BRASILEIRO SA PETROBRAS	61.3	27.0	BRAZIL	Energy

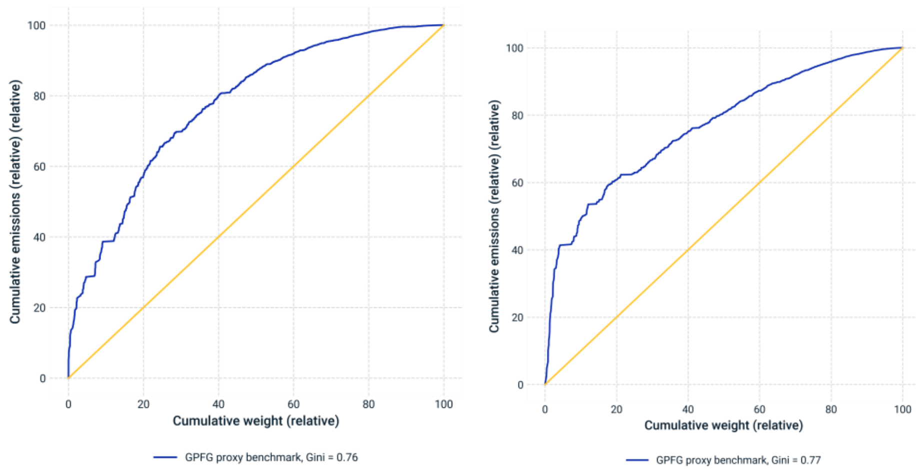
Data as of June 30, 2021. Source: MSCI ESG Research LLC

We observed a similarly high level of emissions concentration in a few emitters from the energy, materials and utilities sectors at a regional level (see Appendix Exhibits A3 to A6).

While Scope 1 emissions were very concentrated, we observed clearly lower levels of concentration in Scope 2 and 3 emissions (Exhibit 21), because these scopes describe how emissions are distributed along companies' value chains.

Exhibit 21: Lorenz curve of companies' Scope 2 and 3 emissions in GPFG proxy benchmark

Scope 2 emissions **Scope 3 emissions**



Data as of June 30, 2021. Source: MSCI ESG Research LLC

EXPLAINING HISTORICAL TRENDS IN EMISSIONS

In Exhibit 13 we observed an overall upward trend in Scope 1 emissions that was interrupted in 2020 by the pandemic's effect on business activity. However, this drop was temporary, with company emissions forecast to rebound in 2021 (MSCI, 2021; World Meteorological Organization et al., 2021).

To explain the long-term upward trend in emissions, we looked at how sectors and regions contributed to the increase over a five-year period from June 30, 2016, until June 30, 2021 (Exhibit 22).

The increase in GPFG proxy benchmark constituent emissions was entirely due to an increase in emissions in emerging markets, while developed-market emissions decreased. In EM, the main source of emissions increase was the materials sector. By contrast, in DM, the main source of decrease was the utilities sector, which provides evidence for the beginning energy transition in developed markets, especially in North America and Europe.

Exhibit 22: Sector and region contributions to changes in Scope 1 emissions

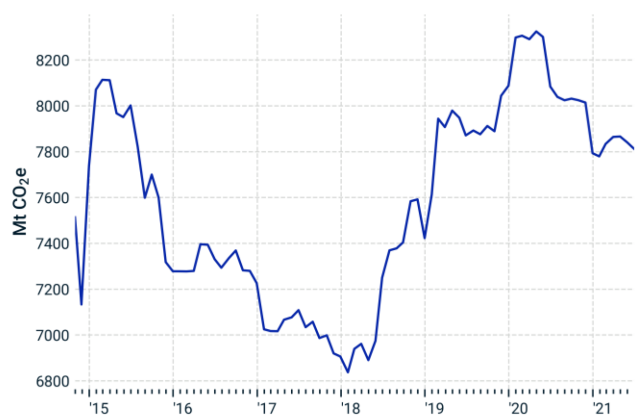
GPFG proxy benchmark Scope 1 emissions change - 5y

	EMEA	North America	Pacific	EM	Sector total
Energy	-0	-45	-7	255	203
Materials	-105	-57	-34	699	502
Industrials	-52	2	-32	151	69
Consumer Discretionary	-2	12	-1	21	30
Consumer Staples	-6	6	6	17	23
Health Care	0	1	0	5	6
Financials	-6	-46	-16	-3	-71
Information Technology	0	4	1	5	10
Communication Services	0	2	-0	1	2
Utilities	-196	-235	-73	194	-310
Real Estate	1	4	9	2	17
Region total	-365	-353	-146	1346	481

Data from June 30, 2016, to June 30, 2021. Source: MSCI ESG Research LLC

Within emerging markets, most of the increase in Scope 1 emissions in the GPFG proxy benchmark was the partial inclusion of China A stocks in the benchmark in 2018, as shown in Exhibit 23.

Exhibit 23: History of Scope 1 emissions due to partial inclusion of China A stocks in GPFG proxy benchmark



Data from June 30, 2016, to June 30, 2021. Source: MSCI ESG Research LLC

EXPLAINING GPFG'S EMISSIONS

GPFG's proxy benchmark differs from the MSCI IMI mainly because of differences in regional weights and customized exclusions. While the difference in regional weights had no impact on the total sum of Scope 1 emissions, the latter had a clear impact, due to the reduction in the underlying universe of companies. We display the differences in Scope 1 emissions between the GPFG proxy benchmark and the MSCI ACWI IMI to contributions from sectors and regions in Exhibit 24.

Exhibit 24: Scope 1 emissions in GPFG proxy benchmark vs. ACWI IMI

	EMEA	North America	Pacific	EM	Sector total
Energy	-20	-68	-2	-327	-417
Materials	-55	-11	0	-284	-350
Industrials	-9	-3	0	-20	-31
Consumer Discretionary	-0	0	0	-4	-4
Consumer Staples	-1	-7	-0	-8	-17
Health Care	0	0	0	-0	-0
Financials	-0	0	0	-0	-0
Information Technology	-0	0	0	-0	-0
Communication Services	-0	0	0	-0	-0
Utilities	-112	-502	-208	-1615	-2438
Real Estate	-0	0	0	-0	-0
Region total	-197	-590	-211	-2259	-3258

Data as of June 30, 2021. Source: MSCI ESG Research LLC

In total, annual Scope 1 emissions in the GPFG proxy benchmark were almost 3.3 Gt lower than in the MSCI ACWI IMI (or 29% lower as of June 30, 2021), mainly due to the exclusion of high emitters in emerging markets utilities, energy and materials sectors. In addition, reduced emissions in the North American utilities sector also contributed to the GPFG proxy benchmark's lower Scope 1 emissions.

Analysis of emission intensities

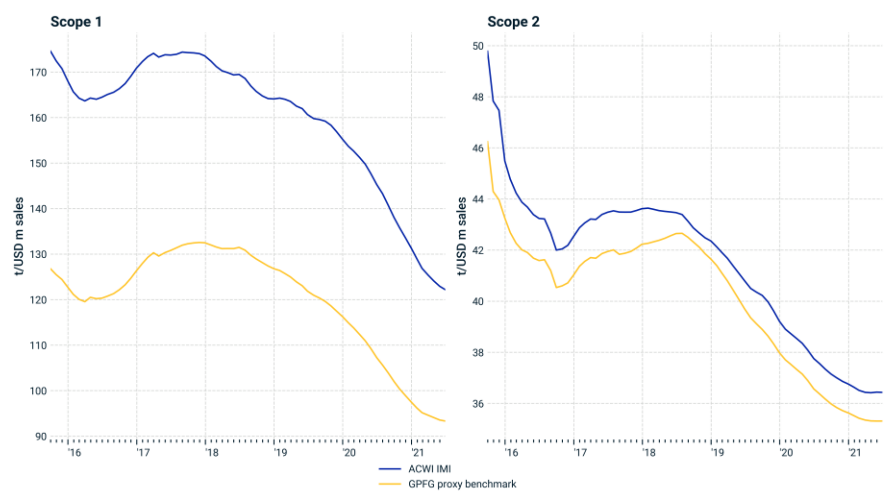
In this chapter, we will look at companies' carbon intensities (i.e., their emissions in relation to the size of their business as measured by their sales in U.S. dollars). Calculating the ratio of company emissions and sales is a meaningful adjustment that enables us to compare the emissions of companies with different business sizes. In addition, we weigh each company's carbon intensity by the respective index weight to arrive at the Weighted Average Carbon Intensity (WACI) of the benchmark.

The TCFD recommends using emissions intensity and WACI because it allows investors to understand the degree to which a firm's business activities are based on carbon emissions (TCFD, 2021b). These measures also enable investors to compare the climate profile of different benchmarks.

DEVELOPMENT OF EMISSION INTENSITIES

Exhibit 25 looks at the development of weighted carbon intensities in the MSCI ACWI IMI and the GPFG proxy benchmark for both Scope 1 and 2 emissions (the history of Scope 3 emissions was not available for the study period).

Exhibit 25: History of weighted Scope 1 and 2 emissions intensity

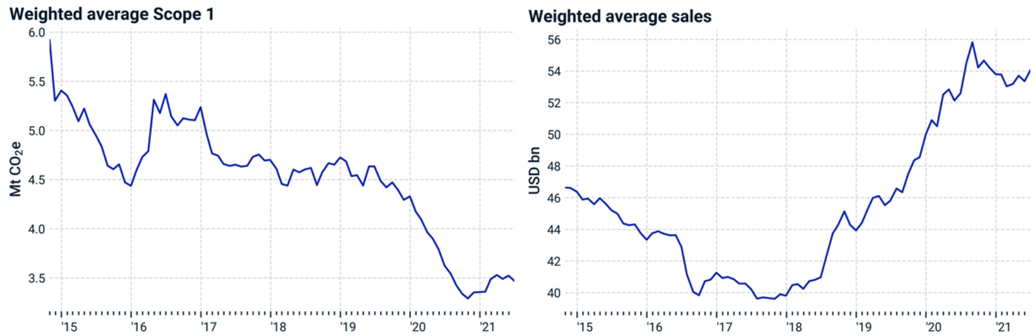


Data from from Oct. 31, 2014, to June 30, 2021. Rolling 12-month averages. Source: MSCI ESG Research LLC

There was a clear difference between weighted emission intensities, which showed a decline during the study period for both benchmarks, and the level of absolute emissions (Exhibit 13), which increased during the same period.

There are two reasons for this discrepancy, as shown in Exhibit 26: First, during the study period, index-weighted emissions have declined due to a shift in sector weights: Carbon-intensive sectors (energy, utilities) weights fell while less carbon-intensive sectors (information technology) recorded a significant increase, especially during the pandemic's start in 2020. Second, index-weighted sales increased as well, driven both by economic expansion and by a relative shift of index weights toward sectors with high earnings growth (information technology).

Exhibit 26: Index-weighted Scope 1 emissions and USD sales



Data from Oct. 31, 2014, to June 30, 2021. Source: MSCI ESG Research LLC

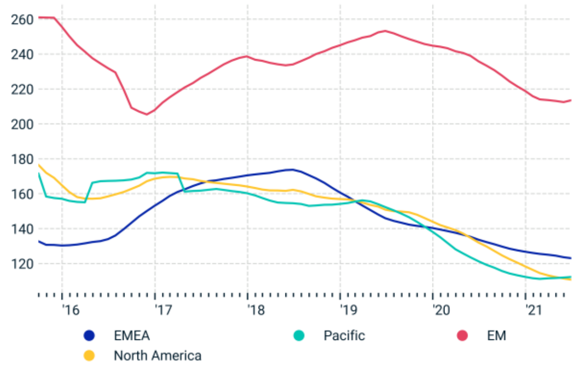
In short, absolute benchmark emissions (the total sum of companies' Scope 1 emissions) did not decrease, but relative benchmark emissions (i.e., emissions relative to the size of sales and weight of the company in the benchmark) declined.

EMISSION INTENSITY BY REGION

Looking at regional emission intensities in Exhibit 27 we found the highest emission intensity in emerging markets, which mirrors the results in Exhibit 16, where we found EM to have the highest level of Scope 1 emissions. However, emission intensities in emerging markets showed a declining trend despite the increase in absolute emissions before the pandemic, due to increasing sales and a relative shift in benchmark weights toward sectors with lower-emission intensity.

Emission intensities decreased in all regions except EMEA, where they trended sideways. The strongest relative decline in emission intensity was found in North America, where the sales growth and relative weight increase in the information technology sector led to a decrease in index-weighted emission intensity.

Exhibit 27: Index-weighted Scope 1 and 2 emission intensity by region in GPFG proxy benchmark

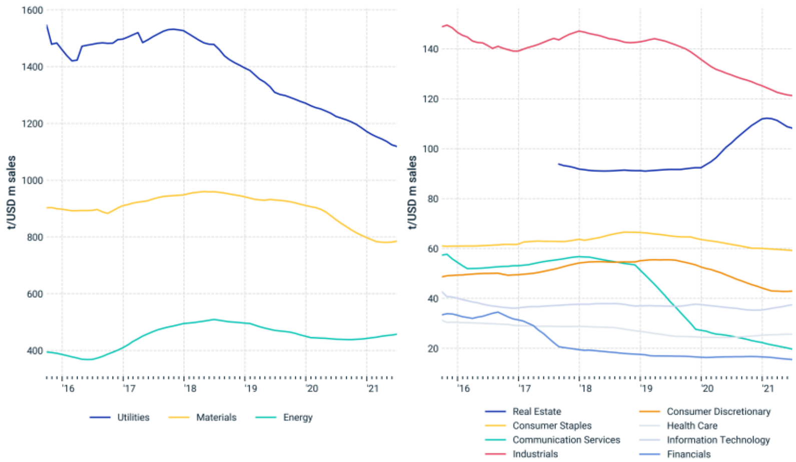


Data from Oct. 31, 2014, to June 30, 2021. Rolling 12-month average. Source: MSCI ESG Research LLC

EMISSION INTENSITY BY SECTORS

Looking at emission intensity by sectors shows that the utilities sector was by far the most emission-intensive sector in the proxy benchmark (Exhibit 28), (similar to what we found for absolute emissions). However, the difference between the utilities sector and all other sectors was even larger than the absolute levels shown in Exhibit 17, which means utilities' businesses were extremely emission-intensive when compared with their sales revenue. At the same time, utilities posted the strongest decline in emissions intensity (and absolute emissions), which indicates the ongoing transition of the utilities sector toward less emission-intensive energy sources in developed markets, such as replacing coal with natural gas or the use of renewables.

Exhibit 28: Index-weighted Scope 1 and 2 emissions intensity by sector

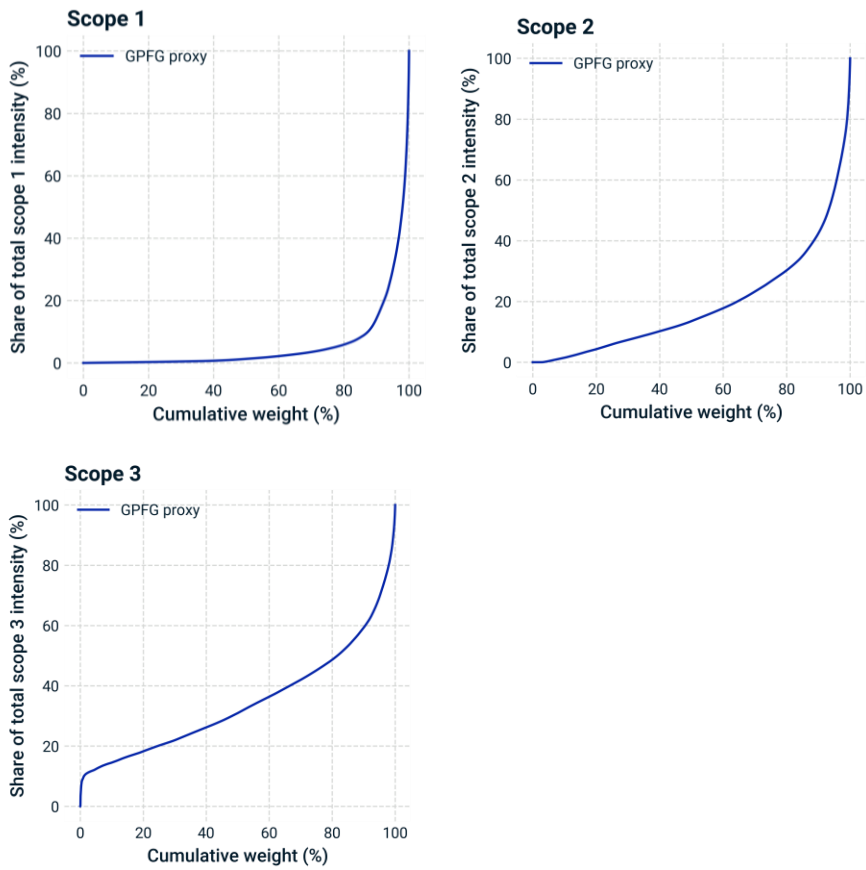


Data from Oct. 31, 2014, to June 30, 2021. Rolling 12-month averages. Source: MSCI ESG Research LLC

CONCENTRATION OF EMISSION INTENSITIES

In the previous section, we found absolute GHG emissions to be highly concentrated. In the following analysis, we looked at whether the same result holds for emission intensities. However, because emission intensities are not additive (like absolute emissions), we used a slight modification of the Lorenz curve concept. In Exhibit 29 we sorted companies in increasing order of emission intensity and plotted the average emission intensity over the cumulative weight of benchmark constituents for Scope 1, 2 and 3 emission intensities, respectively.

Exhibit 29: Lorenz curve of companies' Scope 1, 2 and 3 emission intensity in GPFG proxy benchmark



Data as of June 30, 2021. Emission intensities were scaled to percentages of the emission intensity of the full benchmark for comparison purposes. Source: MSCI ESG Research LLC

The highest concentration of GHG emission intensities in companies' Scope 1 emissions occurred in biggest emitters, i.e., the top fifth of companies were responsible for over 90% of emission intensities in the GPFG proxy benchmark. Concentration levels were clearly lower in Scope 2 emission intensities (the top 40% of companies caused about 80% of emission intensities). Scope 3 emission intensities were the least concentrated, which echoes the results from the previous section.

EXPLAINING HISTORICAL TRENDS IN EMISSION INTENSITY

We observed a decline in emission intensity in the GPFG proxy benchmark. To probe deeper, we looked at sectoral and regional contributions to this trend (Exhibit 30). As noted earlier, by far the largest contributor to the decline in emission intensity was the North American utilities sector, driven by a shift from very emission-intensive sources of energy (coal) to less intense sources, such as gas or renewables. This trend was also mirrored at a global level. The other two sectors contributing to the decline in emission intensity were information technology and communication services, but here the main effect was from the increasing weight of these less-carbon-intensive sectors in the benchmark (see Appendix Exhibit A7 for more details on selection and allocation effects).

Exhibit 30: Sectoral and regional contributions to 5-year changes in emissions intensity

	EMEA	North America	Pacific	EM	Sector total
Energy	-0.8	-2.7	-1.2	1.2	-3.5
Materials	-4.9	-1.9	-2.6	3.9	-5.6
Industrials	-2.4	-0.5	-0.9	0.8	-3.1
Consumer Discretionary	-0.0	-0.4	0.5	-1.8	-1.8
Consumer Staples	0.7	1.1	0.2	0.3	2.2
Health Care	0.9	-0.6	0.1	-0.2	0.1
Financials	3.2	0.2	1.6	0.3	5.4
Information Technology	-1.2	-6.6	-0.1	1.4	-6.5
Communication Services	0.5	-5.9	-0.2	-1.5	-7.1
Utilities	-3.9	-11.8	-1.2	0.5	-16.3
Real Estate	-0.7	-0.7	-0.5	-0.3	-2.3
Region total	-8.8	-29.8	-4.5	4.5	-38.5

Data from June 30, 2016, to June 30, 2021. Source: MSCI ESG Research LLC

EXPLAINING GPFG'S EMISSION INTENSITY

GPFG's benchmark differs from the MSCI IMI mainly due to differences in regional weights (Exhibit 7) and customized exclusions. Both these differences can have an impact on the emission intensity of the GPFG proxy benchmark when compared with the MSCI ACWI IMI. In Exhibit 31, we break down these differences in emission intensity by sectoral and regional contributions.

Exhibit 31: Emission intensity of GPFG proxy benchmark vs MSCI ACWI IMI

	EMEA	North America	Pacific	EM	Sector total
Energy	0.7	-2.8	0.1	-0.2	-2.2
Materials	5.7	-2.7	0.4	-1.6	1.9
Industrials	-2.0	0.9	-0.2	-0.1	-1.4
Consumer Discretionary	-2.3	1.8	-0.2	-0.4	-1.1
Consumer Staples	-1.5	1.4	-0.0	-0.0	-0.2
Health Care	-2.6	2.5	-0.1	-0.1	-0.3
Financials	-3.4	2.4	-0.3	-0.2	-1.5
Information Technology	-1.7	5.0	-0.1	-0.0	3.1
Communication Services	-0.7	2.0	-0.1	-0.2	1.0
Utilities	0.5	-21.0	-1.2	-5.2	-26.9
Real Estate	-0.3	0.2	-0.1	-0.0	-0.2
Region total	-7.5	-10.3	-2.0	-8.0	-27.8

Data as of June 30, 2021. Source: MSCI ESG Research LLC

The main contributor to lower emission intensities in the GPFG proxy benchmark was the utilities sector in both North America and emerging markets.

Analysis of implied temperature rise

Our analysis so far has been focused on companies' emission profiles, which is essentially a measure of companies' status quo in terms of climate profile. However, investors may seek a more forward-looking assessment of how companies' emission trajectory may be aligned or misaligned with the objective of limiting global temperature rise to below 2°C.

MSCI ESG Research developed the Implied Temperature Rise metric, which allows investors to align with the TCFD's (2017a) recommendation. Implied Temperature Rise shows the warming potential of a financial asset based on its current GHG emissions and projected decarbonization trajectory. The key advantage of this climate metric is that it allows investors to assess their alignment with key developments, such as companies' emission-reduction commitments to limit global temperature rise to 2°C or 1.5°C. Such climate metrics could be used for asset allocation, risk management, engagement with portfolio constituents and communication to investors.

According to the TCFD's (2021a) consultation on climate metrics, 43% of the respondents in financial services were using implied temperature rise to monitor the climate risk of their portfolios. Moreover, 45% of the respondents were either disclosing implied temperature rise or planning to disclose it. The UN-backed Net-

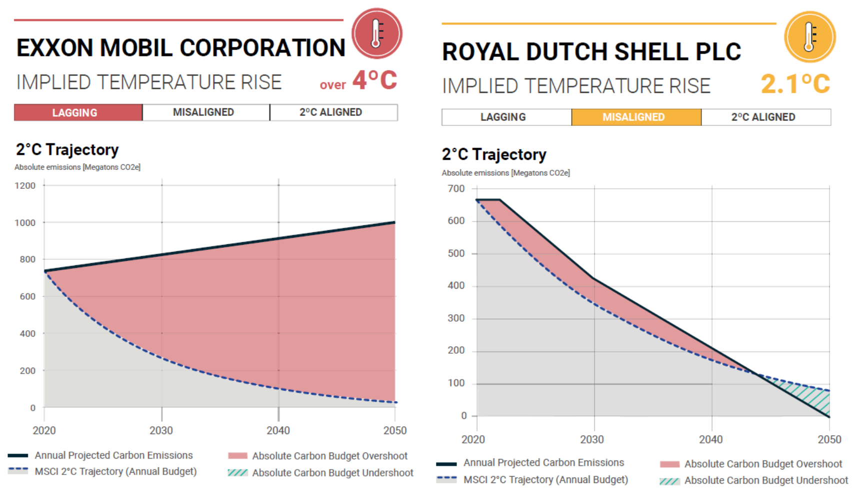
Zero Asset Owner Alliance also supports using implied temperature rise as an important tool to measure alignment (Environmental Finance, 2021).

MSCI's Implied Temperature Rise calculation methodology has three steps: First, for each company we estimate a remaining emissions budget that it would have to cover all cumulative future emissions to be aligned with a 2°C target. Next, we estimate cumulative future emissions for each company, based on its current emissions and decarbonization targets. The difference between projected emissions and remaining emission budgets is called the budget-overshoot (if positive) or budget undershoot (if negative).

The third step calculates the ratio of each company's budget overshoot to the budget. This ratio is then translated into an Implied Temperature Rise, using the TCRE (Transient Climate Response to Cumulative Emissions) calculation metric discussed in the TCFD's (2021c) technical supplement (see Appendix Exhibit A8).

As an introductory example, we compare the remaining emission budgets, projected cumulative emission trajectory and Implied Temperature Rise of Exxon Mobil with those of Royal Dutch Shell (Exhibit 32).

Exhibit 32: MSCI Implied Temperature Rise comparison



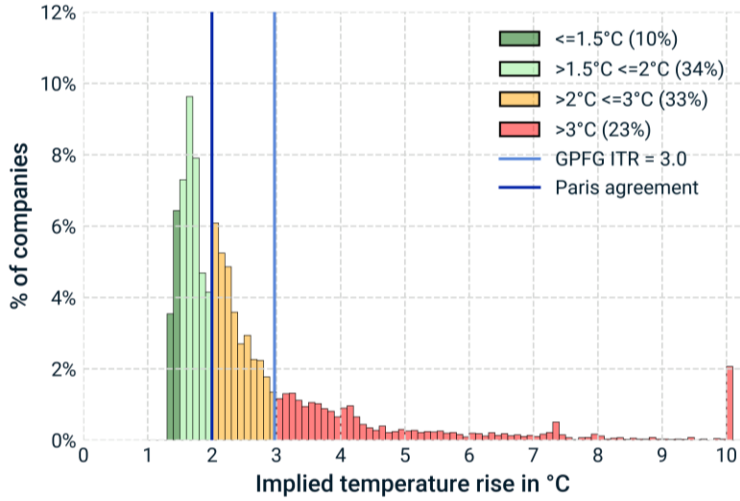
Data as of June 30, 2021. Source: MSCI ESG Research LLC

At the time this report was drafted, both companies had similar levels of current GHG emissions, but very different projected emission trajectories: Royal Dutch Shell has made commitments to cut its emissions, while Exxon Mobil had not. This led to an Implied Temperature Rise of 4°C for Exxon but 2.1°C for Shell.

Exhibit 33 looks at the distribution of companies' Implied Temperature Rise in the GPFG proxy benchmark. We observed a strong upward skew of the distribution, with a tail of companies reaching temperatures even above 5°C. At the same time, close to 10% of companies were aligned with reaching a temperature scenario of 1.5°C. This does not mean that these companies are emission-free as of today — it means that their decarbonization trajectory is in line with reaching a low temperature in the future. We observed similar levels of upward skew in the distribution of Implied Temperature Rise in all four subregions and every GICS sector (Appendix Exhibits A9 and A10).

This exhibit also illustrates that the aggregate temperature rise of the GPFG proxy benchmark — which we calculated by pooling all constituents' remaining emissions budgets and their projected overshoots or undershoots — was about 3°C, well above the objective of the Paris Agreement to maintain global warming well below 2°C.

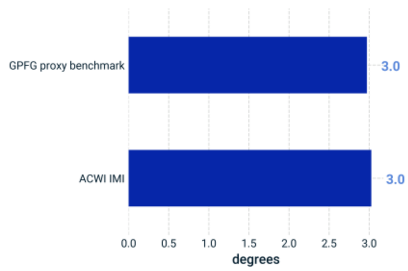
Exhibit 33: Cross-sectional distribution of MSCI Implied Temperature Rise in GPFG proxy benchmark



Data as of June 30, 2021. Source: MSCI ESG Research LLC

Exhibit 34 compares MSCI's Implied Temperature Rise of the two benchmarks. The GPFG proxy benchmark showed almost the same temperature rise as did the MSCI ACWI IMI — even though we found the former to have a lower emission-intensity profile. This is because emissions-based measures present the current snapshot of the benchmark's climate profile, whereas Implied Temperature Rise measures constituents' projected decarbonization pathway. Firms not aligned with decarbonization pathways may drag down a benchmarks' implied temperature rise.

Exhibit 34: Comparison of MSCI Implied Temperature Rise by benchmark

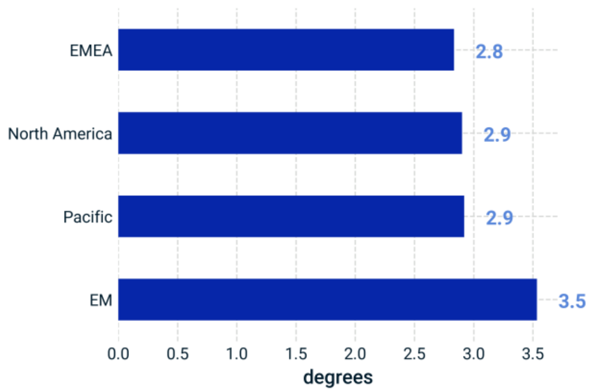


Data as of June 30, 2021. Source: MSCI ESG Research LLC

IMPLIED TEMPERATURE RISE BY REGION

Exhibit 35 shows the Implied Temperature Rise (as measured by MSCI's metric) for each region comprising the GPFG proxy benchmark. Developed-market regions all had a temperature rise close to 3°C, while emerging markets showed significantly higher temperatures. Not only did emerging-market companies showed higher current emission intensities (as observed in the previous section), but their projected emission trajectories also were less aligned with global decarbonization goals.

Exhibit 35: MSCI Implied Temperature Rise by region in the GPFG proxy benchmark

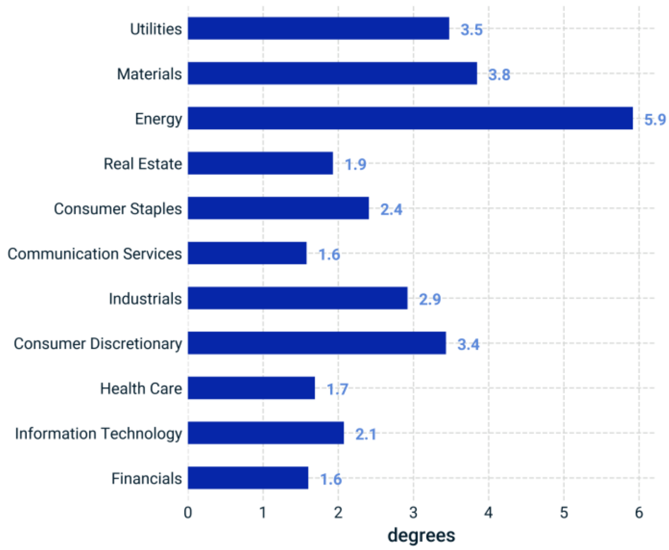


Data as of June 30, 2021. Source: MSCI ESG Research LLC

IMPLIED TEMPERATURE RISE BY SECTOR

Next, we looked at Implied Temperature Rise by GICS sector (Exhibit 36) within the GPFG proxy benchmark. Not surprisingly, the highest temperature rise was observed in the most emission-intensive sectors, i.e., energy, materials and utilities.

Exhibit 36: MSCI Implied Temperature Rise by GICS sector in GPFG proxy benchmark



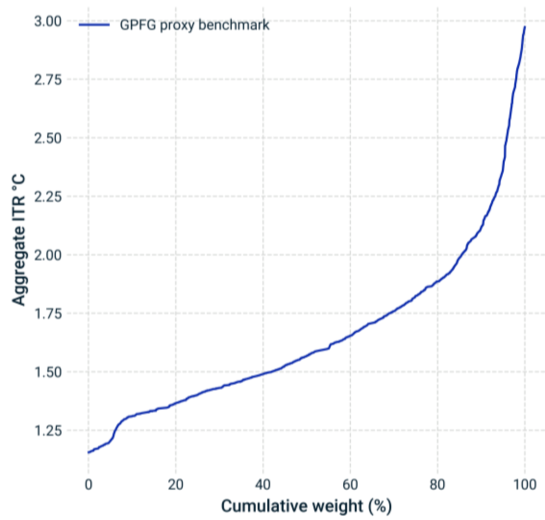
Data as of June 30, 2021. Source: MSCI ESG Research LLC

This reflects the fact that the most carbon-intensive sectors were also the ones that face the biggest challenge to decarbonize their businesses models. Therefore, their projected emission pathways were the most misaligned with reaching a temperature rise goal well below 2°C.

CONCENTRATION OF TEMPERATURE RISE

In the previous two sections, we found absolute emissions and emission intensities to be highly concentrated. Exhibit 37 looks at the concentration of implied temperature rise in the GPFG proxy benchmark. To be precise, we ordered companies by increasing implied temperature rise and then plotted the average temperature of constituents (y-axis) versus the cumulative weight of constituents (x-axis).

Exhibit 37: Concentration of Implied Temperature Rise in GPFG proxy benchmark



Data as of June 30, 2021. Source: MSCI ESG Research LLC

The result shows levels of concentration and skewness similar to those observed in Exhibit 33: The “coldest” 40% of companies (in terms of benchmark weight) showed an average temperature rise of 1.5°C and the “coldest” 85% showed an average temperature rise of 2°C. It was the 15% of companies with the highest temperature rise that increased the average temperature in the GPFG proxy benchmark to about 3°C. If the “hottest” 15% companies were excluded from the benchmark, the average temperature rise would have been aligned with 2°C; excluding the hottest 60% would have achieved an alignment with 1.5°C.

To achieve either temperature target, some companies could be hotter or colder than the temperature targets. However, we saw in Exhibit 33 that the number of individual companies misaligned with a 1.5°C and 2°C rise was clearly higher than 60% and 15%, respectively: 90% of companies (in terms of the number of constituents) in the GPFG proxy benchmark were not aligned with a 1.5°C temperature rise and 56% were misaligned with a 2°C target.

EXPLAINING GPFG'S IMPLIED TEMPERATURE RISE

Implied Temperature Rise in the GPFG proxy benchmark (using MSCI's metric) was found to be slightly lower than in the MSCI ACWI IMI. Exhibit 38 attributes these differences to sectors and regions.

Exhibit 38: Implied Temperature Rise of GPFG proxy benchmark vs. MSCI ACWI IMI

	EMEA	North America	Pacific	EM	Sector total
Energy	0.02	-0.08	0.00	-0.00	-0.05
Materials	0.00	-0.01	0.00	-0.01	-0.02
Industrials	-0.01	0.01	0.00	0.00	-0.00
Consumer Discretionary	0.02	0.00	0.00	0.00	0.02
Consumer Staples	-0.01	0.02	-0.00	-0.00	0.01
Health Care	-0.01	0.03	-0.00	-0.00	0.01
Financials	-0.03	0.02	-0.00	-0.00	-0.02
Information Technology	-0.01	0.02	-0.00	-0.00	0.01
Communication Services	-0.01	0.01	-0.00	-0.00	0.00
Utilities	-0.00	-0.01	0.00	-0.01	-0.01
Real Estate	-0.00	0.00	-0.00	-0.00	0.00
Region total	-0.04	0.01	0.00	-0.02	-0.05

Data as of June 30, 2021. Source: MSCI ESG Research LLC

Overall, differences in temperature rise were small. The main contributor to lower temperature-rise values in the GPFG proxy benchmark was the energy sector and the main regional contributor was EMEA. A detailed analysis of allocation and selection effects (Appendix Exhibit A11) showed that the main reason was due to allocation effects, i.e., the relative underweighting in North America and the relative overweighting in EMEA in the GPFG proxy benchmark.

EXPLAINING CROSS-SECTIONAL DIFFERENCES IN TRANSITION RISK

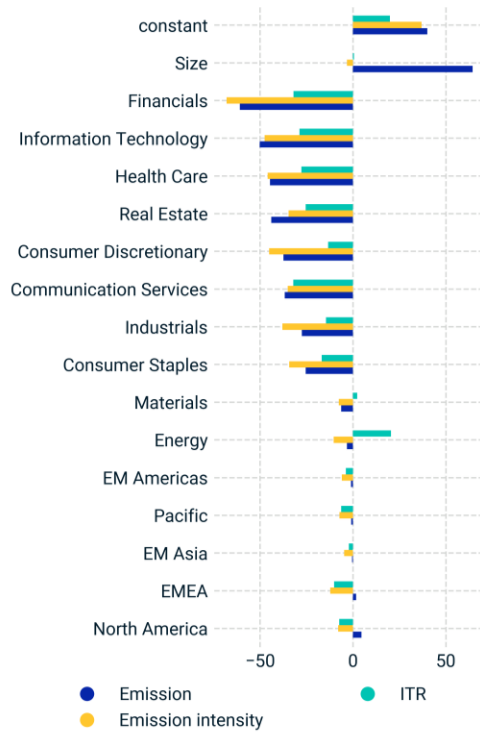
In the previous analysis, we observed clear differences in emissions, emission intensities and implied temperature rise values across regions and sectors. The question is, what drives or explains cross-sectional differences in these variables? To address this question, we regressed the logarithm of companies' absolute emissions, emission intensities and Implied Temperate Rise respectively using companies' size (logarithm of market capitalization in USD), sectors and regions as explanatory variables.[6]

[6] The distribution of raw emissions had a large skewness and kurtosis. Using a logarthmic scale brings the distribution closer to a normal distribution.

Exhibit 39 shows that the most statistically significant explanatory variable for absolute emissions was company size, which is not surprising because companies' size of operations can be expected to have a huge influence on absolute emissions. In addition, sectors were highly relevant as well, as the type of business a company operates largely defines its carbon footprint. By contrast, regions were much less significant than company size and sectors.

However, size was not a statistically relevant variable when we looked at emission intensity and implied temperature rise. This is because emission intensity and implied temperature rise are already size-adjusted measures. However, sectors were statistically significant in explaining companies' emission intensities and implied temperature rise and were more significant than regions.

Exhibit 39: T-stat of cross-sectional regression coefficients



Data as of June 30, 2021.To avoid collinearity, the EM EMEA and utilities sectors were removed from the explanatory variables. Source: MSCI ESG Research LLC

The overall R-squared for the regression of emissions and emission intensities was 63% and 56%, respectively, which means a large part of cross-sectional differences in these variables was explained by the regression (Exhibit 40).

However, the R-squared of the regression for implied temperature rise was 46%, i.e., clearly lower than the R-squared in the regression of emission intensities and absolute emissions. This may be due to the fact that implied temperature rise is determined not only by companies' emissions, but also by their decarbonization efforts and targets, which may vary considerably even within a given sector, as we saw in Exhibit 35.

Exhibit 40: Explanatory power of regression analysis as measured by R-squared

	Emission	Emission intensity	ITR
R^2	64.3%	56.4%	46.0%

Data as of June 30, 2021. Source: MSCI ESG Research LLC

Section II: Climate scenario analysis

In the first section of this report, we looked at companies' climate-transition risk exposure through the lens of their emission profiles. In this section, we use scenario analysis tools to assess the projected emissions trajectory of the GPFG proxy benchmark against different NGFS climate scenarios. As we discuss, scenario analyses can be very helpful when facing high levels of uncertainty.

Scenarios represent potential manifestations of how a particular outcome (e.g., CO2 emissions) will evolve under various future states based on a set of assumptions, providing a forward-looking measure.

We also use forward-looking analysis for physical risk and transition risk. As previously discussed, physical risk reflects the potential financial impact from changes in weather conditions, such as increased likelihood of hurricanes, and transition risk describes risks (and opportunities) from companies' need to adjust their business models to transition to a low- or net-zero emissions economy. The analysis in this section provides insights into the sources and distribution of physical risks and transition risk.

Emissions scenarios

We start by laying the foundation of scenario analysis, followed by a discussion of NGFS scenarios and projected carbon emissions for the GPFG benchmark under different scenarios.

Climate change is likely to have a long-lasting effect on the way business is conducted. However, the magnitude and timing of when such climate-induced changes may materialize remains uncertain. Many factors, such as socioeconomic trends, political agendas, regulation and technological innovation, further influence how well businesses can respond to the threat of climate change.

IPCC (2018) argues that climate change also could expose human, ecological and physical systems to compound risks in which multiple disasters strike simultaneously or successively, such as drought resulting in higher wildfire risk, which is then succeeded by torrential rain, resulting in land damage. These uncertainties are too complex and uncertain to assess, especially when relying on historical information. A recent report by Bolton et al. (2020) argues that physical and transition risks can have nonlinear chain reaction effects, which makes it very difficult to put an economic value on the potential damage of climate change.

Given the inherent complexity and uncertainty surrounding the way in which climate risks and opportunities affect the way business is conducted, the TCFD recommends using scenario analysis to assess the implications of climate change (TCFD, 2017a). Scenario analysis for climate change is a forward-looking assessment of how a particular outcome (e.g., CO2 emissions) will evolve under alternative plausible future states based on the researcher's assumptions and constraints.

It is a critical tool to help businesses prepare for an uncertain and complex future and can be used as a guiding tool for policymakers (NGFS, 2021a). A straightforward example of this could be how GHG emissions evolve until 2100, assuming there is no change in a business as usual, or "BAU" scenario. Investors also may want to explore how GHG emissions evolve until 2100 in order to keep global warming under 2°C. This is commonly referred to as the "2°C scenario."

Scenarios are important for asset managers and asset owners to understand how climate change may affect the resilience of their portfolios. They highlight the financial implications of different transition and physical risk scenarios.

DEFINITION OF NGFS SCENARIOS

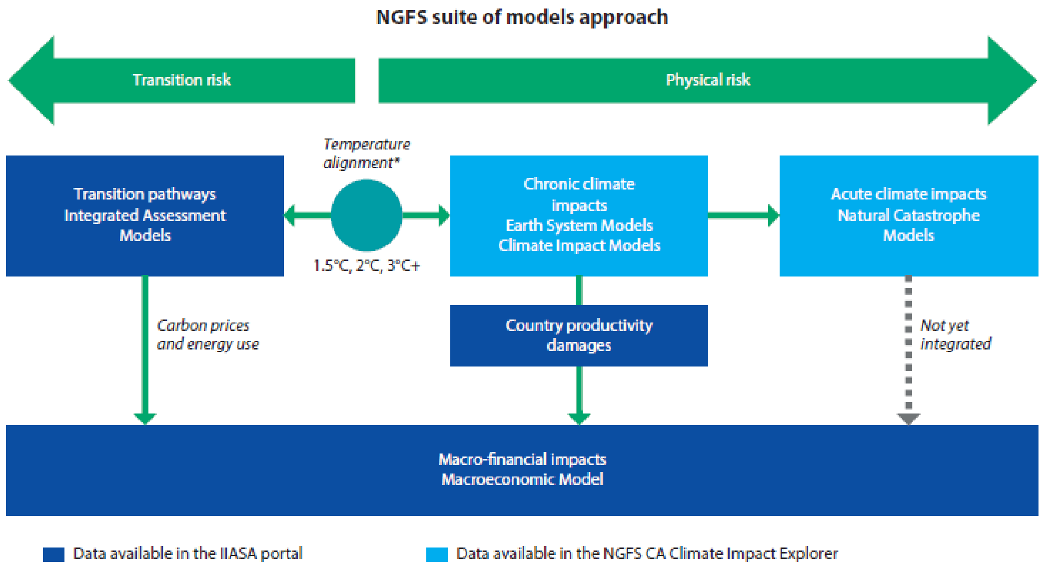
There are numerous scenarios possible for how climate change may affect the real world and the economy. For the purposes of this report, we focus on a set of scenarios proposed by the Network for Greening the Financial System, a consortium of 91 central banks and supervisors and 14 observers. NGFS has proposed a set of detailed scenarios that allows different businesses to adopt coherent and consistent tools. The discussion below is adapted from NGFS' technical documentation on climate scenarios.

To propose a set of alternative scenarios, NGFS looked at over 1,000 economic, financial, transition and physical risk variables. Exhibit 41 presents the conceptual underpinning of their scenario-based approach to determine how climate risk affects macro-financial outcome variables. The transition risk pathway assesses how climate policies, regulation, technological innovation and consumer preferences may affect profitability and wealth.

It is modeled using so-called Integrated Assessment Models (IAMs), which are quantified mathematical models that determine the environmental and economic impact of carbon emissions and any feedback effect from climate to the society. IAMs quantify these complex interactions and feedback loops by considering the evolution of various economic, social and technological factors. Each IAM makes various assumptions about the evolution of various mitigation policies, such as energy-intensity improvements and technology (Guivarch and Rogelj, 2017).

Each potential transition-risk pathway affects a corresponding physical-risk pathway, which consists of the transmission of chronic weather conditions into economic damage (acute climate impacts have not yet been integrated as shown in Exhibit 41). Each pathway consists of various models, including integrated assessment models and catastrophe-damage models that dictate the evolution of the macro-financial impact of climate change.

Exhibit 41: Conceptual underpinning of NGFS scenarios



Source: Network for Greening the Financial System

With this conceptual underpinning, the NGFS has proposed six different scenarios that are based on three key design choices for the transition pathway: policy choices (long-term and short-term), long-term temperature target and technology coordination. Each scenario is briefly explained below:

1. **Net-Zero 2050:** This scenario limits global warming to 1.5°C. It assumes that climate policies have been adopted early and are stringent, which allow the world to transition to net-zero emissions smoothly. Technological innovation in low- and zero-carbon technologies is assumed to be high, while the removal and storage of existing CO2 allows gradual phaseout of liquid fuels. Policy coordination across different geographies is also assumed to be medium, mitigating concerns that global policies will never converge.

2. **Below 2°C:** This scenario's policy ambition is to limit global warming to 1.7°C by assuming that climate policies are adopted early but become stringent gradually. Policies are not as stringent as in the Net-Zero 2050 scenario and CO2 emissions

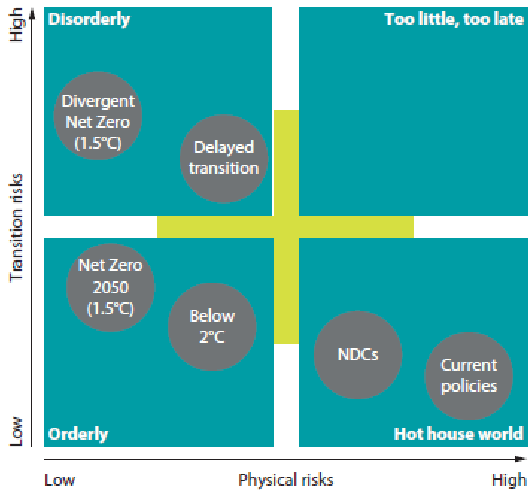
do not reach net-zero before 2070. Technological innovation of green technologies is moderate and CO2 removal is low. There is lower variation in regional policies that gradually become more stringent.

3. **Divergent Net-Zero:** Long-term temperature target for this scenario is 1.5°C but the trajectory in terms of policy implementation and coordination diverges by sector. Climate policies are not uniform, with transportation and building sectors having stringent policies. Innovation for green technology is fast because the world needs to do more and within a shorter duration to achieve 1.5°C global warming. However, the feasibility of CO2 removal technology is limited. Divergent policies and rapid course correction result in high transition costs.
4. **Delayed Transition:** Long-term temperature target is 1.8°C. Annual emissions do not decrease until 2030. Regional coordination for climate policies is divergent because countries and regions differ in their responses to limit global warming to below 2°C. The world needs to implement stringent policies to have a 67% chance of limiting global warming to below 2°C. Any removal of CO2 is low because of difficulties in research and/or commercialization of the technology.
5. **Nationally Determined Contributions:** Climate targets pledged by different countries limit global warming to 2.5°C (as of beginning of 2021). Climate targets set by countries are heterogeneous but not stringent enough to limit global warming to 1.5°C. Technological innovation for green technology is slow and CO2 removal is also low. Because countries do not impose stringent targets, there is room for coordinated regional policies.
6. **Current Policies:** Long-term temperature rise is above 3°C because this scenario assumes that only currently implemented policies restrict GHG emissions. Any future targets are not accounted for, which implies that policy variation across regions is low. Technological innovation is low and the technology for CO2 removal is not feasible.

Because these scenarios impose different assumptions regarding potential temperature targets, they also have varying expected transition and physical risks. Exhibit 42 shows the position of each scenario on a matrix representing physical and transition risks. The orderly transition scenarios (**Net-Zero 2050 and Below 2°C)** have subdued physical and transition risks because they assume climate policies are immediately introduced that become more stringent over time.

Disorderly transition scenarios (**Divergent Net-Zero** and **Delayed Transition)** suffer from delayed and/or less-coherent policy responses across countries, but can limit global warming below 2°C, which may result in high transition risk but low physical risk. The remaining two hot-house world scenarios have low transition risk but high physical risk due to insufficient carbon-reduction efforts from different countries.

Exhibit 42: NGFS scenarios and physical/transition risk matrix



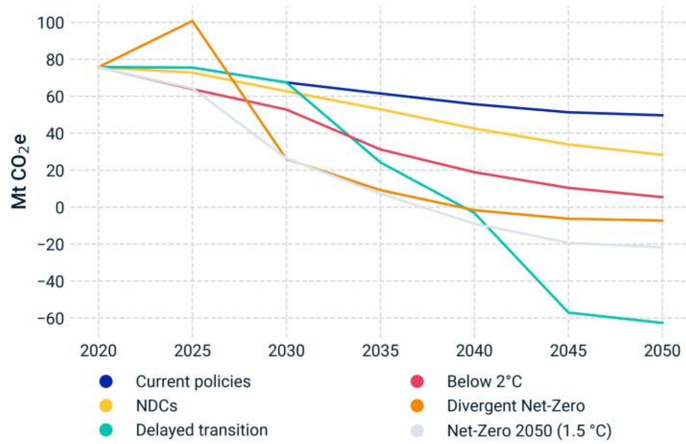
Source: Network for Greening the Financial System

NGFS scenarios have been implemented by various institutions, including 31 of its members, as part of their risk management approach to identifying and assessing climate risks (NGFS, 2021c). The TCFD also recommends the use of the Below 2°C scenario, current policies, NDCs and physical risk scenarios (TCFD, 2017c). Similarly, the UN Net-Zero Asset Owner Alliance was supportive of the recent updates to scenarios released by the 2020 World Energy Outlook (WEO).

WORLD EMISSIONS UNDER DIFFERENT NGFS SCENARIOS

Each of the six NGFS scenarios affect the global projected CO2 emissions trajectory, as shown in Exhibit 43 below. The orderly transition scenarios (Net-Zero 2050 and Below 2°C) are projected to result in a downward-sloping emissions trajectory that is immediate and stringent. CO2 emissions under the disorderly transition scenarios (Divergent Net-Zero and Delayed Transition) assume a pathway where climate policies result in a rapid reduction in emissions due to the lack of regional coordination. Emissions projection for the remaining two scenarios increases over the short to medium term, after which they adopt a downward sloping trajectory.

Exhibit 43: Future emission pathways of NGFS scenarios



Source: Network for Greening the Financial System

A key takeaway from this exhibit is that investors need to practice caution when interpreting each scenario. There is significant uncertainty on where the world will end up in 2050, with projected CO2 emissions ranging from net-zero to more than 40Gt. The NGFS report further notes that there are various other uncertainties that affect our interpretation, such as the inability of models to account for complex behavioral patterns and how the financial market will allocate capital to businesses.

Putting transition-risk scenarios into context

The key takeaway for transition risk scenarios is pricing the cost of carbon emissions and their anticipated impact on the emission pathways. Exhibit 44 (top left) shows how carbon prices are projected to evolve until the turn of this century. How big could this impact be? An intuitive way to understand the potential impact of different scenarios on transition risk can be to understand how the price of a barrel of oil would evolve under each scenario. This can be compared with the potential oil-price shock that financial markets experienced in 1973-74.

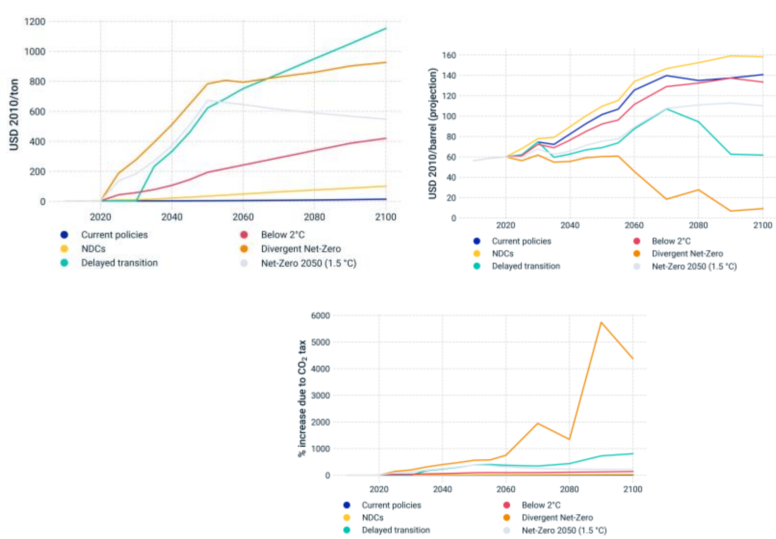
For this analytical exercise, we calculated the implied effect on oil prices by multiplying the projected CO2 price by the average CO2 content of a barrel of oil, which is estimated as 0.43 ton/barrel. Oil prices are also projected in the NGFS scenarios using supply-cost curves and are expressed in dollars/GJ. Assuming that the carbon price is fully built into the oil price, the price effect can be calculated as shown on the lower left-hand side of Exhibit 44.

As of the time of the writing of this report, a barrel of oil costs around USD 70. As an example, in a severe scenario such as the Delayed Transition scenario, the price is expected to rise to USD 73 by 2040, and approximately USD 166 could be added on top of that price, assuming a full carbon tax. This would lead to a roughly 3.4-fold price increase in oil.

If one compares this to the oil-price shock between October 1973 and March 1974 (fourfold increase from roughly USD 3 to USD 12), the climate-transition effect seems smaller and especially slower, making it easier to adjust to potential effects without serious hindrance on usual economic development.

The relative impact of the carbon tax is expected to be larger, however, in the case of the Divergent Net-Zero scenario, because of the projected decrease in the oil price in that scenario (especially beyond 2060), which increases the share of the carbon tax in the projected oil price.

Exhibit 44: Estimated future carbon price and its effect on the oil price in NGFS scenarios



The cost of climate risk

In this chapter we look at the projected costs and opportunities of climate change, using MSCI's Climate VaR methodology based on NGFS scenarios. The implications of such scenarios for companies are dependent on their exposures to both transition and physical risks. The underlying transition-risk model of MSCI's Climate VaR focuses on companies' future costs of adjustment (policy risk) to decarbonize their business models and their potential to generate new revenue through green technology. The physical-risk component brings both acute and chronic climate developments into perspective. It adopts a layered approach based on the exposure of company facilities to natural hazards, their vulnerability to financial harm and the present and estimated future climate, including the likelihood and intensity of extreme weather events.

Overview: MSCI Climate VaR model

MSCI's Climate Value-at-Risk (Climate VaR) model provides investors a quantitative, forward-looking analysis on how climate change may affect the investment return in portfolios. The model allows investors to assess and mitigate future risks from climate change, while at the same time helps identify potential investment opportunities.

Climate VaR is closely aligned with the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) in that it quantifies both transition and physical impacts in a climate scenario context. To calculate **transition Climate VaR**, the model identifies future policy-related costs and potential green profits linked to specific emission scenario pathways. The entirety of country emission-reduction pledges (Nationally Determined Contributions, or NDCs) has been quantified and normalized to align with a 3°C scenario. Based on the UN Environment Programme's Emissions Gap report (UNEP GAP), the model further quantifies additional emission-reduction requirements necessary to achieve the goals of the Paris agreement to limit global temperature rise to well below 2°C. In addition, to calculate **policy VaR**, the model incorporates a Scope 2 electricity use* and a Scope 3 value-chain model to capture the company's ability to pass-through the cost of electricity as well as factoring in upstream and downstream impacts, for example, for the automobile and oil and gas sectors.

On the opportunity side (**technology opportunity VaR**), the model uses a multifaceted approach to calculate profits using estimated current low-carbon revenue as a starting point. Patent-valuation techniques are then used to estimate the level of "future green revenue." Under this setting, sector-level revenue assumes that a company's cost to comply with climate policy is equal to the revenue for the other. Put differently, exogenous revenue sources coming from potential fiscal policies, such as carbon taxes, are not accounted for. Annual values for firm profits come from low-carbon technologies and are based on historical margins per sector. Technology opportunity VaR discounts future profits in relation to the enterprise value.

To calculate **physical Climate VaR**, an extensive asset location database comprising more than 400,000 company facilities has been overlaid with hazards maps. Each location's climate-related economic impact for 10 extreme weather hazards is assessed with the help of sector-specific asset damage and business interruption functions. The physical-risk scenarios are based on IPCC's (2013) RCP 8.5 pathway. MSCI calculates the **average scenario** by considering the expected value of the cost distribution for the emissions pathway. The complementary **aggressive scenario** is derived from the 95th percentile of the cost distribution and explores the severe downside risk within the distribution tail.

The net present value of all future climate-related costs and green profits is finally related to the current valuation of the asset to provide users with a climate-stressed market valuation, assuming that climate change impacts are currently not priced in.

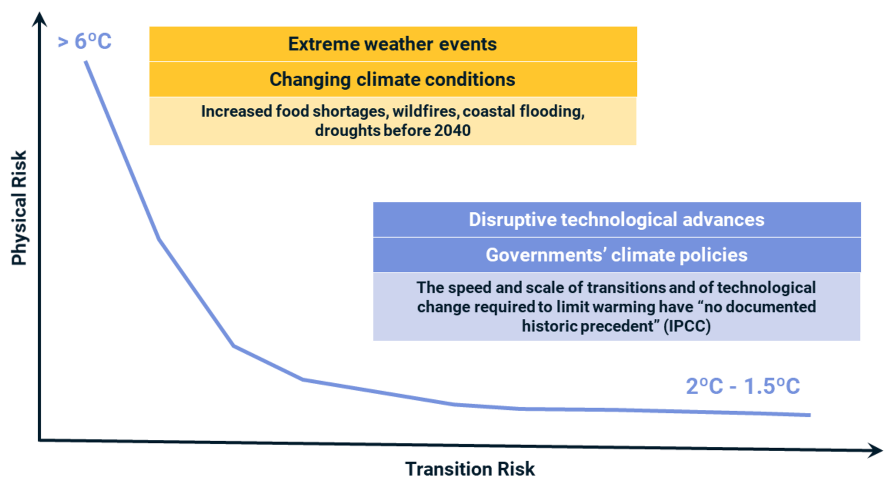
***** The methodology assumes that utility companies will face costs to reduce their emissions, which are captured in their Scope 1 model. Part of their costs can be passed on to consumers, which is modeled through pass-through costs in the model. However, the methodology does not impose assumptions about potential changes in consumer behavior.
** Academic research has shown that patent revenue allows firms to earn abnormal profits over the near future. This can be seen in the theoretical Technology Gap Model (Posner, 1961). However, the effects can vary, depending on what company-performance indicator is being examined. Patent value has been shown to have a positive effect on a firm's Tobin's Q (Neuhausler et al., 2011), which means that patent value can influence the forward-looking performance of firms.

GLOBAL CLIMATE-TRANSITION COSTS

An important aspect of climate risk is the inherent trade-off between climate - transition risk and physical risk, as explained in Exhibit 45: Climate-transition risk can be expected to be most severe if the world delays a shift to net-zero. Such a scenario may have a severe impact on many businesses over the next two decades. However, at the same time, such a scenario would most likely mitigate severe physical risks in the long run.

By contrast, in a business-as-usual scenario, the impact of climate-transition risk would be relatively small. However, the long-term impact of physical risk is estimated to be very severe, as the world warms.

Exhibit 45: Trade-offs between climate-transition risk and physical risk



Source: IPCC and MSCI ESG Research LLC

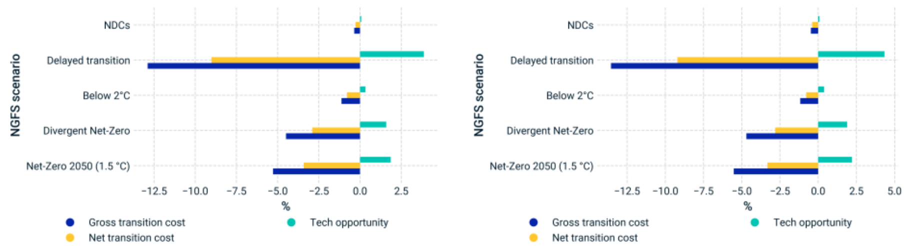
This trade-off between climate-transition and physical risk also applies over time: While almost all the economic impact in a fast-decarbonization scenario can be expected before 2050, in the BAU scenario, most of the physical-risk impact can be expected after 2050.

We use the five NGFS transition scenarios mentioned above to simulate the projected costs of climate-transition risk in the GPFG proxy benchmark as a percentage of market capitalization, while the BAU scenario is used to estimate the costs of physical risks.

In Exhibit 46, we compare two results: the gross climate transition cost estimate, which takes into account only the costs arising from a transition to a low-carbon economy (i.e., policy Climate VaR), and the net transition-cost calculation, which deducts climate opportunities VaR from the policy VaR. Transition opportunities reflect upside potential for some firms in the form of low-carbon revenue from their investment in technological advancements. These are further described in the box titled "Overview MSCI Climate VaR Model" above.

Exhibit 46: ACWI IMI and GPFG proxy benchmark Climate Transition VaRs

MSCI ACWI IMI **GPFG proxy benchmark**

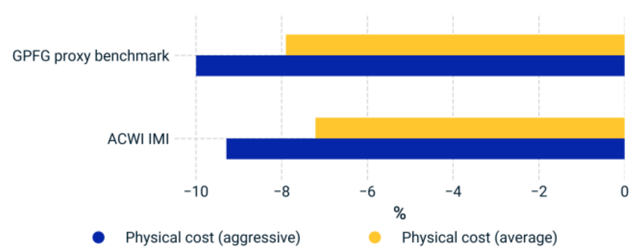


Data as of June 30, 2021. Source: MSCI ESG Research LLC

Across all scenarios, technology opportunity VaR offsets less than one-third of the expected policy costs. The most severe scenario by far was the 2°C delayed scenario due to the extreme costs of late action. It is important to emphasize that the expected climate costs in a 1.5°C scenario with early action were clearly lower than the costs in a 2°C scenario with delayed action. The simulation results for the GPFG proxy benchmark were very similar to the MSCI ACWI IMI's across all scenarios.

For physical risk, we used the two standard scenarios in the MSCI Climate VaR methodology: average and aggressive, (see "Overview: MSCI Climate VaR Model" box above).

Exhibit 47: ACWI IMI and GPFG proxy benchmark cost of physical risk



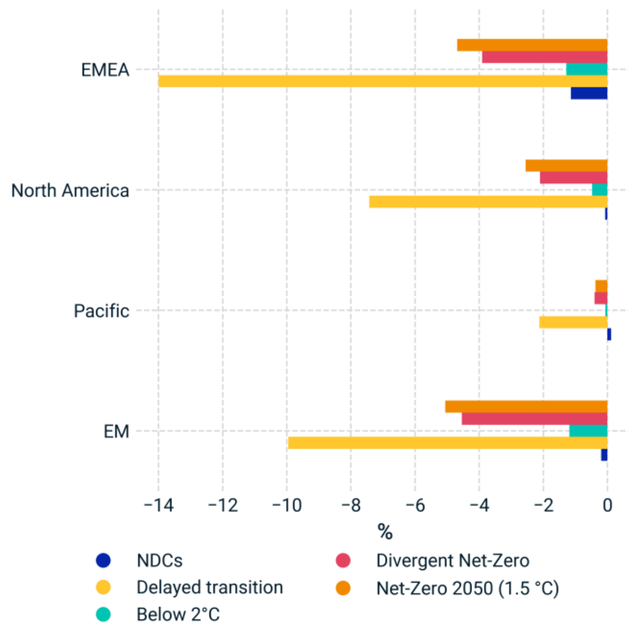
Data as of June 30, 2021. Source: MSCI ESG Research LLC

Exhibit 47 shows that the simulated costs of physical risks were lower than for the most severe transition-risk scenario above. Again, the most severe transition scenario and physical scenarios to a large extent offset each other: The former assumes limiting global warming to below 2°C, which mitigates physical risks, while the latter assumes the opposite: The world does not decarbonize enough to limit global warming.

CLIMATE RISK BY REGION

Exhibit 48 looks at the net transition costs by region for the different scenarios. The Delayed Transition scenario was the most severe scenario across all regions and led to the highest cost estimate in EMEA, while for all other scenarios, emerging markets showed the most severe risks.

Exhibit 48: Net transition costs by region in GPFG proxy benchmark

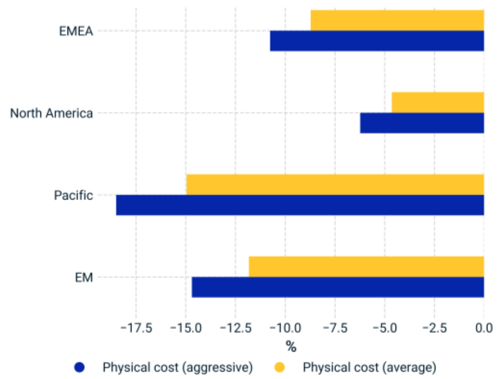


Data as of June 30, 2021. Source: MSCI ESG Research LLC

The Delayed Transition scenario has a disproportionately high impact on Europe and North America as they would face a much stronger relative increase in carbon-emission prices after 2030, compared with the other scenarios. In this scenario, the projected carbon prices for Europe rise tenfold (see Appendix Exhibit A14 for details affecting other regions), from below USD 100 per ton in 2030 to more than USD 1,000 per ton by 2050. A jump in projected carbon prices of this magnitude results in a very adverse financial impact. Europe would be harder hit than North America because the latter has a larger weight in information technology and communications sectors, which are relatively more climate-resilient.

By contrast, physical risks were most severe in Pacific and emerging markets (Exhibit 49).

Exhibit 49: Physical risks by region in GPFG proxy benchmark

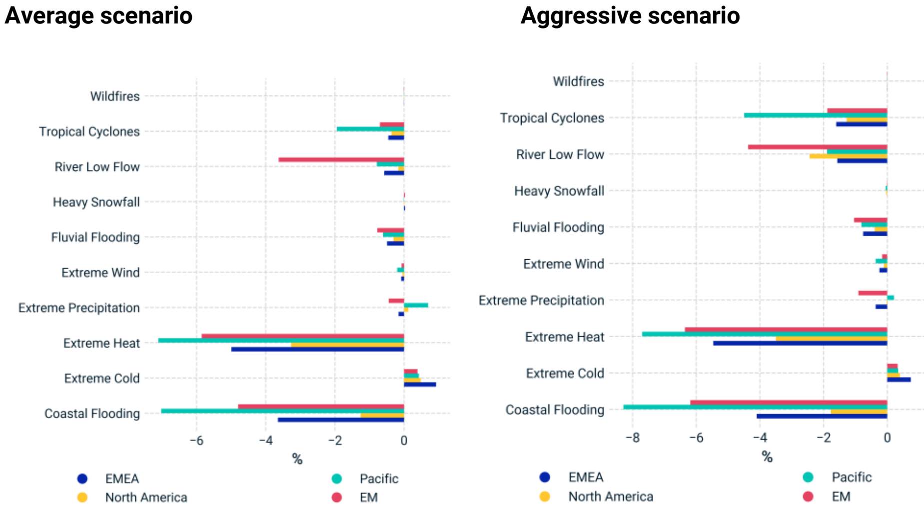


Data as of June 30, 2021. Source: MSCI ESG Research LLC

These regions would be more affected by higher extreme heat and coastal flooding risks, along with higher river low flow and tropical cyclone risks (Exhibit 50).[7]

[7] Some extreme weather scenarios may result in positive risk results representing opportunities.

Exhibit 50: Breakdown of physical-risk costs



Data as of June 30, 2021. Source: MSCI ESG Research LLC

This observation is also consistent with policy-based research that finds that emerging and developing economies face a greater risk from the physical effects of climate change, such as flooding, droughts and cyclones (Financial Stability Board, 2020; World Bank, 2005).

CLIMATE-TRANSITION COST BY SECTOR

When exploring the distribution of climate-transition costs by sector, it is important to understand the components of transition-cost estimates (MSCI Policy Risk Climate VaR). They consist of costs arising from reductions in direct emissions (Scope 1), reductions warranted from electricity use (Scope 2) and reductions from the value chain (Scope 3). The costs under each component are shaped by assumptions regarding how much of the costs are borne by the company and how much can be passed on to others in the value chain.

We briefly discuss these elements for each modeling approach here. The first component relates to the Policy Risk Climate VaR due to direct GHG emissions, which estimates annual emission-reduction costs for each company. However, some of these costs for electricity producers can be passed through to other stakeholders in the value chain. This primarily affects the electricity producers by reducing some of their costs arising from transition risk.

The second component relates to emissions arising from electricity use or Scope 2. Transition to net-zero emissions would increase costs for power utilities in the form of decommissioning old plants and updating electrical grids to accommodate new power sources. The MSCI Electricity Use Climate VaR model assumes that some of the costs for electricity producers are passed to consumers, based on their yearly electricity consumption. The pass-through level calculates how much of the transition costs incurred by an electricity generator can be passed on to its final consumers.

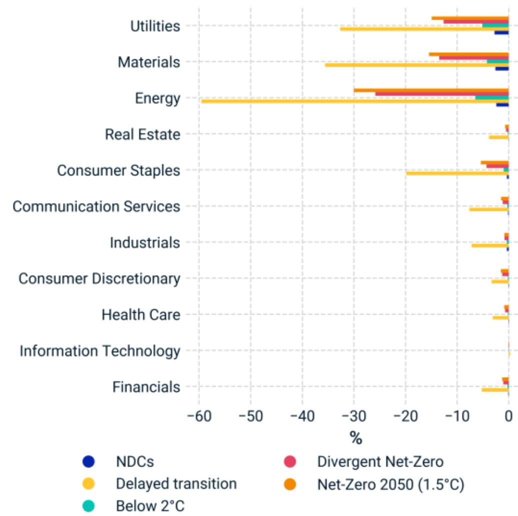
For Scope 3 emissions, MSCI uses its Value Chain Climate VaR approach, in which the value-chain costs may be absorbed by a company due to indirect climate-transition risks stemming from suppliers and customers. This is the so-called burden rate in the MSCI Climate VaR model, which estimates the negative revenue impact due the reduced marketability of fossil-fuel-based products and services. There is significant heterogeneity in the assumed burden rate, varying from 0% to 100% based on sector competitiveness, price elasticities and depth of supply chain.

Taken together, the net effect of the three components is ambiguous for most sectors — except utilities, which manages to pass through some of its costs to downstream firms. Firms in sectors with high price elasticities or ones that are exposed to a more deregulated electricity generation sector may face higher Scope 3 costs, which may reduce the concentration of transition risks in the cross-section of portfolio companies.

Exhibit 51 looks at the simulated net climate-transition costs of sectors within the GPFG proxy benchmark. By far the highest financial impact was found in the energy sector, where in the most extreme scenario the cost impact reached over 50% of the sector’s market capitalization. The materials and utilities sectors showed the second- and third-highest cost impacts. Across all sectors, we found the highest cost impact for the Delayed Transition scenario.

We note that these transition costs were distributed more evenly across sectors than were absolute emissions: The three most carbon-intensive sectors (energy, utilities and materials) absorbed 60% of the total simulated gross transition costs while representing 80% of the total Scope 1 emissions. As explained above, the net impact of pass-through costs depends on various industry- and country-level determinants. For example, the model assumes that (across GICS sectors) 100% of the transportation and 78% of the business travel costs, but none of the commuting costs, are passed on to companies down the value chain. In the energy sector, the model assumes that 55% of the transition costs embedded in oil and gas sold by the sector would be assumed by the extracting companies. Hence, the modeling of pass-through costs that are determined by supply-chain characteristics as well as by assumptions of elasticities could result in cross-sectional heterogeneity in the effects of transition risk (for details see Appendix Exhibit A15).

Exhibit 51: Net transition costs by sectors

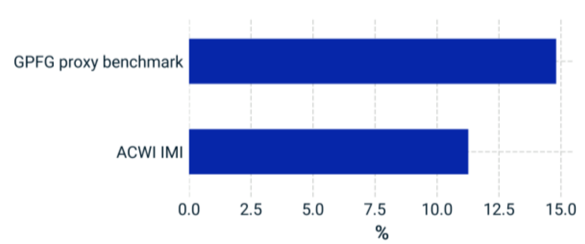


Data as of June 30, 2021. Source: MSCI ESG Research LLC

As the most carbon-intensive sectors face the highest projected transition costs, they are the ones that may need to raise fresh capital to finance the transition to a net-zero economy.

Companies in these emissions-intensive sectors have already begun financing the climate transition, as can be seen in the amount of green-capital expenditures (capex) in the energy and utilities sectors (Exhibit 52). Such firms may have external capital needs to fund their transition, so it may be counterproductive to cut capital supply to high emitters that are looking for ways to change their business models to reach net-zero.

Exhibit 52: Average share of green capex as % total in the energy and utilities sectors

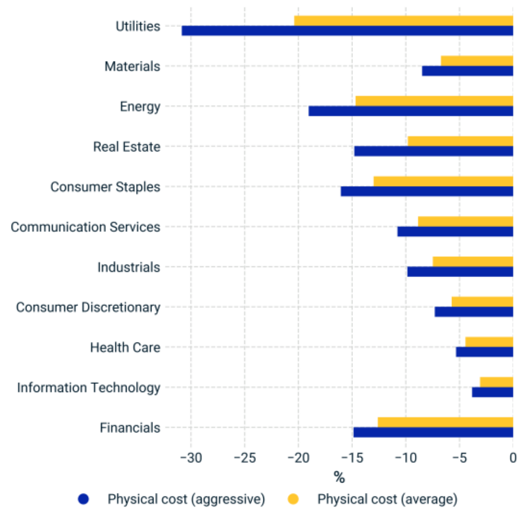


Data as of June 30, 2021. Source: MSCI ESG Research LLC

Exhibit 53 looks at physical-risk estimates in the GPFG proxy benchmark. The utilities sector showed the highest physical-risk cost estimate due to the high vulnerability of utilities' infrastructure to extreme weather conditions (including the impacts from extremely low runoff in rivers and the resulting reduction in power production of hydro and thermal power plants, factors that do not affect other sectors), followed next by the energy sector.

The financial sector showed a high-cost impact from physical risk due to the large number of office locations with high fixed asset values and the economic output assigned to each of those offices.

Exhibit 53: Physical cost by sector in GPFG proxy benchmark

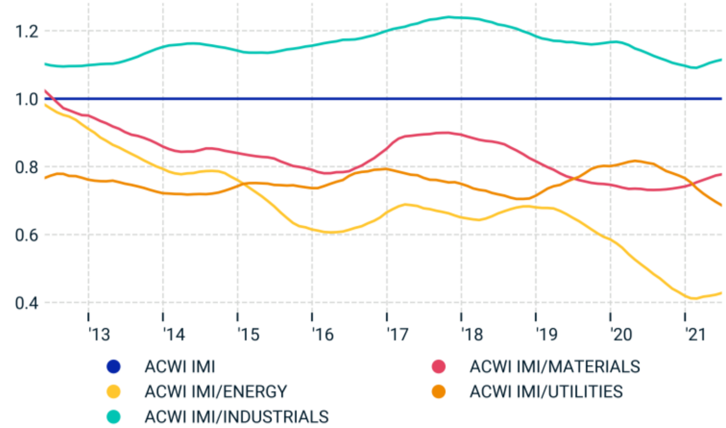


Data as of June 30, 2021. Source: MSCI ESG Research LLC

With growing awareness of climate risks, investors also might ask whether climate risks have been priced into financial markets. To the extent that companies' business models are exposed to transition risks (such as a shift to a low-carbon economy) or physical risks (such as extreme weather conditions), have equity markets started to reflect those risks?

One way to do this is to look at companies' valuation levels in equity markets. Exhibit 54 looks at price-to-book (PB) ratios of MSCI ACWI IMI sectors. We focused on the high Scope 1- and 2-emitting sectors (energy, materials and utilities) and the industrials sector, which has high Scope 3 emissions.

Exhibit 54: Valuation levels (price-to-book ratio) of MSCI ACWI IMI sectors relative to ACWI IMI



Data from June 30, 2011, to June 30, 2021. Rolling 12-month average. Source: MSCI ESG Research LLC

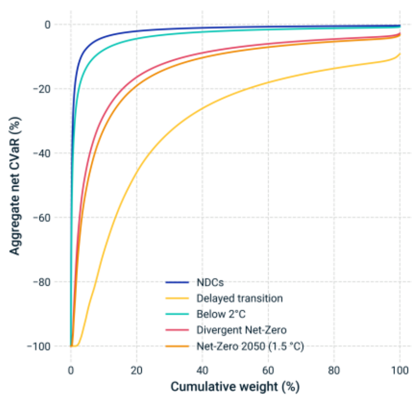
Note that the three sectors with highest Scope 1 emissions (energy, materials and utilities) saw a decline in price-to-book ratios compared with the benchmark over the study period, which provides evidence that equity markets have started to price these sectors at an increasing discount relative to their book value. In Appendix Exhibits A1 and A2, we show that this observation held true even if we controlled for other factors (industry, size and equity style factors) and that this valuation trend was statistically significant.

By contrast, we have not observed a similar trend in the industrial sector, which is mainly indirectly exposed to climate-transition risks through its supply chain (Scope 3 emissions). In short, this indicates that markets may have started to price in climate risks for companies that are directly involved in the fossil-fuel value chain via their Scope 1 emissions, while companies' indirect involvement through their supply chain or their products and services hasn't exhibited similar market effects so far. However, there is limited research on the potential indirect effects of the pricing of climate risks on financial stability. The Financial Stability Board (2020) and other international bodies are now focused on assessing the market-destabilizing effects of climate change that can trigger stability concerns.

CONCENTRATION IN CLIMATE-TRANSITION COSTS

We found very different levels of concentration in the GPFG proxy benchmark across the different simulated scenarios (Exhibit 55). The lowest level of concentration by far was observed in the most severe transition scenario, i.e., Delayed Transition, followed by the 1.5°C scenario. The more severe scenario not only resulted in higher projected transition costs, but these costs were also spread more broadly across the benchmark, affecting more constituents than in the less severe scenarios.

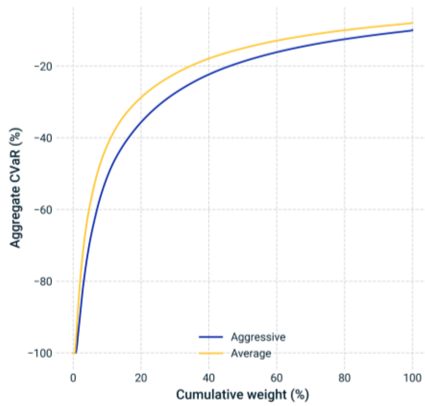
Exhibit 55: Lorenz curve of GPFG proxy benchmark's net transition costs



Data as of June 30, 2021. Source: MSCI ESG Research LLC

A similar finding holds for physical risks (Exhibit 56), where the more severe aggressive physical-risk scenario showed less concentration than the average scenario, meaning the impact of physical costs is expected to spread more widely across the benchmark.

Exhibit 56: Lorenz curve of the GPFG proxy benchmark's physical costs



Data as of June 30, 2021. Source: MSCI ESG Research LLC

EXPLAINING GFPG'S CLIMATE COSTS

Overall, the GPFG proxy benchmark displayed slightly higher climate-transition risks than MSCI ACWI IMI in the most extreme scenario (Delayed Transition). Most of the difference in transition costs can be explained by allocation effects (for a detailed analysis of allocation and selection effects, see Appendix Exhibits A12 and A13). The EMEA region, which on average showed higher levels of transition risk (see Exhibit 48), had higher weights in the GPFG proxy benchmark, which led to higher weights in EMEA energy, materials and utilities sectors, all among the riskiest sectors. By contrast, the GPFG benchmark was underweight in the North America region, especially in the North American information technology sector, whose net transition risk was actually positive.

Exhibit 57: Attribution of GPFG transition costs to MSCI ACWI IMI

	EMEA	North America	Pacific	EM	Sector total
Energy	-0.25	0.30	-0.00	-0.02	0.02
Materials	-0.28	0.11	-0.02	0.03	-0.16
Industrials	0.05	-0.06	0.02	0.00	0.01
Consumer Discretionary	-0.06	-0.09	0.05	0.02	-0.07
Consumer Staples	-0.16	0.19	-0.02	0.00	0.02
Health Care	0.11	-0.10	0.01	0.01	0.03
Financials	0.02	-0.09	0.01	0.00	-0.06
Information Technology	0.10	-0.34	0.03	0.03	-0.19
Communication Services	-0.11	-0.07	0.00	0.01	-0.17
Utilities	-0.11	0.40	0.02	0.03	0.34
Real Estate	0.02	-0.02	0.01	0.00	0.01
Region total	-0.66	0.21	0.12	0.12	-0.22

Data as of June 30, 2021. Source: MSCI ESG Research LLC

The attribution of differences in physical risks using the aggressive scenario shows slightly higher risks in the GPFG proxy benchmark than the MSCI ACWI IMI. Again, the overwhelming majority of this difference was due to allocation effects. The GPFG had lower weights in the North American information technology sector, which had the lowest physical risk, and it had higher weights of similar size in the EMEA financials sector, which had a high level of physical risk. Furthermore, the Pacific region — which was the riskiest region — had a higher weight in the GPFG, leading to an additional increase in physical risks. (Exhibit 58).

Exhibit 58: Attribution of GPFG physical costs to MSCI ACWI IMI

	EMEA	North America	Pacific	EM	Sector total
Energy	-0.09	0.02	-0.00	-0.00	-0.08
Materials	0.04	-0.02	-0.01	-0.01	0.01
Industrials	0.10	-0.06	-0.04	-0.01	-0.00
Consumer Discretionary	0.06	-0.09	-0.02	0.00	-0.06
Consumer Staples	-0.07	0.10	-0.01	0.00	0.02
Health Care	0.08	-0.08	0.00	0.00	0.01
Financials	-0.23	-0.01	-0.02	-0.03	-0.29
Information Technology	0.09	-0.28	0.00	-0.01	-0.20
Communication Services	-0.09	-0.05	-0.01	-0.00	-0.15
Utilities	-0.10	0.13	0.01	0.03	0.07
Real Estate	-0.00	-0.00	-0.02	-0.00	-0.03
Region total	-0.21	-0.35	-0.11	-0.04	-0.71

Data as of June 30, 2021. Source: MSCI ESG Research LLC

Section 2 emphasized stress test GPFG's benchmark against different climate scenarios. This exercise revealed that the evolution of climate risk is dependent on the rate at which different climate policies are implemented, and how well coordinated they are. If the policies are implemented early and gradually, the models suggest that transition-risk effects are moderate, except in a few carbon-intensive sectors. However, a delayed response by policymakers or lack of coordination may trigger climate events (known as tipping points) that induce even greater uncertainty and adverse impacts.

The damage functions modeled across different scenarios indicate that physical risks could materialize in the second half of this century. Crucially, physical risk is higher if countries are unable to manage their transition to a net-zero world. When physical risks do materialize, our analysis shows that they tend to be less concentrated than transition risks, although emerging and developing economies tend to face a larger disruption.

CLIMATE-RISK APPROACHES AND LIMITATIONS

Forward-looking climate-risk estimates are based on scenarios that represent potential outcomes. Naturally, such projections — especially when looking out as far as 2100 — are uncertain and subject to limitations.

This sub-section briefly explains the two approaches — top-down and bottom-up — for quantifying potential climate-risk impacts on financial markets.

1) The **top-down approach** (or "macro" approach) starts with modeling global emissions and global carbon-emission budgets from country-level data.

Country-level emissions can be more robust and allow institutions to model a wider range of types of damage (NGFS, 2020). The approach then models climate-risk impacts at a global macroeconomic level — i.e., simulating the impact on gross domestic product (GDP), interest rates, inflation and other variables and then deriving a top-down impact on prices across different asset classes.

This type of analysis is commonly conducted by financial authorities, with limited involvement of individual financial institutions, because they are responsible for ensuring macroprudential stability; the top-down approach helps regulators understand the impact of climate risk on the broader economy and financial system. Such an approach is helpful in understanding the influence of macroeconomic variables, such as interest rates and taxes, but it has limited potential to deliver precise estimates at the company level.

2) The **bottom-up approach**, which models the impact of climate risk on companies' future costs and earnings, discounts them to get to an impact on enterprise value and then aggregates these company-specific impacts to arrive at an estimate for the aggregate effect on financial markets. The MSCI Climate VaR methodology follows this approach, as it provides detailed risk estimates at a company, sector, country or regional level for equity and fixed-income markets.

   There are various advantages to using the bottom-up approach, such as more in-depth analysis of the drivers of climate risks (NGFS, 2020). Because the bottom-up approach aggregates micro-level company data, the models may be limited in their ability to simulate how companies and the broader economy can dynamically adjust. However, the bottom-up approach remains grounded in each firm's business model and therefore can be tailored to the idiosyncrasies of different companies.

Notably, some central banks now use a hybrid approach that mixes bottom-up and top-down approaches (NGFS, 2021a).

PHYSICAL RISK AND UNCERTAINTY

One of the inherent differences between the top-down and bottom-up approaches is their respective assessments of the economic consequences of climate change.

Using a top-down approach, NGFS estimated cumulative macroeconomic damage from climate risk in a hot-house scenario until the year 2100 to be around 15% of global GDP. Discounted to today, this macroeconomic impact appears to be much smaller than MSCI's estimate of the financial impact on listed companies' enterprise value (presented in this section), which uses a mixed approach combining various elements of the bottom-up (e.g., assessments done at the facility level and aggregated to coarser levels) and top-down approaches (e.g., climate projections for acute risk evolve until the year 2100).

What can explain this difference? The discrepancy can largely be explained by the fundamental differences in modeling climate risks and the underpinning assumptions about future states of the world (NGFS, 2021a): MSCI's physical-risk model estimates future costs to companies both due to asset damage and interruption of business operations as a direct consequence of an extreme weather event (acute risk) and gradual changes in revenue (chronic risk). According to MSCI's physical climate-risk models, the most significant future changes in financial loss for companies come from an increase in coastal flooding risk, based on a global average. In contrast, NGFS' estimates are based on chronic physical-risk impacts only and therefore are limited in their ability to capture any event-driven impact on companies.

Prior academic work also documents wide variation in the impact of temperature on GDP losses (Nordhaus, 2018; Kalkuhl and Wenz, 2020; Kahn et al., 2021), which arises because of differences in modeling techniques. For instance, the NGFS (2021a) says that most of the studies do not assess the disastrous impact of climate tipping points on global temperatures, and therefore underestimate the projected impact on GDP losses. Moreover, recent research by Conway et al. (2019) highlights the multitude of differences in terms of assumptions and modeling choices that exist between top-down and bottom-up approaches. They propose adopting a blended approach to offer richer insights into the effects of climate change.

Further, the difference may be due to the fact that financial markets show a stronger reaction to risks than does GDP. A stream of academic literature has documented that losses in real economic output have resulted in steep declines in stock-market valuation and increases in volatility, such as the recent impact of COVID-19 on global GDP and stock markets. Fernandes (2020) shows that the average GDP decline of 4.5% for the U.K. resulted in stock-market losses of over 40% in 2020. The loss-amplification factor (computed as stock-market losses to GDP losses) is similarly high for various other countries, such as the U.S. (6.9), Germany (6.9) and Spain (6.7) (Fernandes, 2020). The IMF's Global Financial Stability Report (2020) further showed that COVID-19 resulted in sharp increases in equity portfolio flows out of emerging markets. This further exposes stock-market participants to liquidity risk and redemption risk that exacerbate volatility concerns. Using a sample of 76 different countries, Sergi et al. (2021) show that COVID-19-induced GDP declines were one of the key reasons behind stock-market losses.

TRANSITION RISK AND UNCERTAINTY

By its very nature, assessing the impact of transition risk requires an understanding of how the drivers of climate risk transmit risk across the financial system. This transmission can arise due to shifts in factors reflecting political economy, technological innovation, investor and consumer sentiment and their interaction with each other. A recent report by the Bank for International Settlements (BIS, 2021) notes that the evolution of these drivers is highly uncertain because of limited knowledge about their magnitude and timing, the geographically diverse impact of climate change and how climate tipping points would exacerbate the uncertainty. While scenario analysis always involves making assumptions about various states of the world, the scale and complexity of these drivers and the uncertainty involved mean that any scenario may be vulnerable to "blind spots."

The TCFD urges companies using scenario analysis to be aware of inherent assumptions of each pathway, because these blind spots may result in a wide dispersion in calculated/estimated company-level impacts (TCFD, 2020). Moreover, the report also acknowledges that public scenarios tend to be at a macro scale (e.g., global) and lack granularity. Companies that implement scenario analysis need to pay careful attention to various key pathway characteristics and implicit assumptions, such as the assumptions about energy mix, technology innovation and policy responses.

An assessment conducted by the U.K.'s Financial Reporting Council (2020) noted that, for climate disclosures, companies exercise a substantial degree of latitude in disclosing their scenario outputs. However, companies provided very little detail on the inputs and specific assumptions underlying their scenario-analysis exercise.

Estimates of carbon prices are also affected by high levels of uncertainty. The carbon price is defined as the net cost of emitting an additional unit of CO2 in USD terms. It is a crucial policy instrument linked to how different regions meet their climate targets under different scenarios (NGFS, 2021b). Scenarios where carbon emissions need to be cut in a more stringent manner impose higher carbon prices.

There are currently several published scenarios that vary in terms of their assumptions about the timing of policy changes, changes in energy systems and technology adoption (TFCD, 2017c; NGFS, 2021b). These have a direct bearing on the implicit carbon price. While the IEA scenarios are more specific as to how global energy systems evolve, NGFS relies on IPCC scenarios (TCFD, 2017c).

An unintended consequence of these scenarios is that they result in differing opinions of how carbon prices may evolve in the future. This is because of assumptions about future emissions, the response of the climate to such emissions, impact of such climate changes back to the society and estimates of economic damage (Carbon Brief, 2017). For instance, higher CO2 emissions but a stringent climate target would impose a rapid carbon price-increase trajectory, but higher CO2 emissions and weaker climate targets would result in lower carbon prices.

Academic researchers have also noted a significant variation in carbon prices due to model assumptions and limitations (Metcalf and Stock, 2017; Gambhir et al. 2019). Recent systematic research of more than 204 global carbon-price projections by Meyer et al. (2021) showed that the interquartile range of 2050 carbon prices ranged from USD 158 to USD 805 per ton, with the maximum observed exceeding USD 14,300 per ton.

There is significant variation in carbon prices, even within the six scenarios proposed by NGFS. Exhibit 44 shows that the 2050 carbon-price projections could range from just above zero (Current Policies) to more than USD 1,100 per ton (Delayed Transition).

Another source of uncertainty is that these models do not account for behavioral changes, differences in policy implementation and the market allocation of capital (NGFS, 2021b).

In short, investors may want to be cautious when interpreting carbon prices, because they differ substantially based on IAM scenarios and related input parameters. IAMs are still developing, and inherent model uncertainties may remain for some time.

Section III: Climate Benchmarks

Broad market-cap indexes such as MSCI ACWI IMI are the standard to measure the performance of public equity markets. By construction, they are designed to represent the entire market and thus serve as a fair yardstick to measure the risk and performance of portfolios.

Over time, investors have sought to replicate index performance through index funds, underpinned by the efficient-market model, which basically assumes that all available information is reflected in current security prices. The theory posits that any information that investors may want to use to “beat the market” is already reflected in asset prices.

Investors may have different investment objectives in terms of the markets they would like to invest in and the level of diversification they are seeking. These objectives affect their choice of benchmark.

The Norwegian Ministry of Finance has set the following objective regarding its choice of equity benchmark: “The investment objective for the GPFG is to achieve the highest possible return measured in international currency, given an acceptable level of risk. When assessing the equity benchmark, the Ministry emphasizes cost effectiveness, broad diversification of the investments and harvesting of risk premiums. The benchmark index shall be rule-based, verifiable and transparent, as well as adapted to the distinctive characteristics of the Fund, such as size and investment horizon.”

The GPFG’s current equity benchmark is constructed to provide broad representation of the international equity market and is weighted by companies’ market capitalization, which mirrors the investment risk and performance of the average market investor. If an investor opts for a different benchmark composition, it may be because that investor is faced with other investment conditions, assesses the investment environment differently or has investment objectives that don’t match those of the average investor.

Broad changes in the investment landscape may present challenges for traditional benchmarks. In recent years, environmental, social and governance (ESG) and climate investing have emerged as a growing trend in both active and index-based investing. These types of investments typically deviate from the broad market-cap portfolio in seeking to achieve climate or ESG-related investment objectives.

While there is a proliferation of ESG and climate research models and related indexes, all are built to address either or both of the following questions: 1) How well does a company manage environmental, social and governance risks that could affect its enterprise value? (This is what MSCI ESG Ratings are designed to do.) 2) Is a company "good" or "bad" for society and the environment? (I.e., does it have a positive or negative social impact, regardless of whether that impact is relevant to investors?) Other providers' ESG ratings may focus more on this second question, or on a mix of the two. (MSCI ESG Research provides other models and datasets focused on this second question.)

These different objectives and approaches help explain why there are substantial variances in ratings. Another reason is limited data availability or consistency for certain ESG-related issues, which means data providers have to develop appropriate proxies, which may vary across providers.

In this section of the report, we look at standard MSCI Climate Indexes and how they address climate change in the index construction methodology and their financial profile.

Integrating climate change into benchmarks

Climate investing is emerging as an important trend within ESG investing and has led to the development of dedicated climate indexes. Use of such benchmarks may influence investors' asset allocations. As for the broader trend of ESG investing, there are two primary reasons investors may want to change from a market-cap benchmark to a climate benchmark:

1. To address long-term risks that markets may not necessarily price efficiently. As explained above, there is a high level of uncertainty to climate change, due to possible developments that market participants may not be able to anticipate and that may lead to unexpected repricing of assets. For that reason, the TCFD recommends the use of scenario analysis to simulate such a surprise repricing, as discussed in Section II. Building these risks into climate indexes aims to make index-based investments more resilient under such scenarios.
2. To incentivize companies: By shifting capital from climate-change laggards to climate-change leaders, investors may change companies' valuation levels and cost of capital and therefore steer climate laggards toward improving their climate-transition strategy.

In practice, investors may follow both objectives in investments that seek to reflect or track climate indexes. Climate change is implemented into indexes using one or several of the following investment objectives:

1. **Reducing emissions** and **mitigating stranded-asset risks.**

2. Tilting toward **climate-solutions** businesses, which may form a "natural hedge" against stranded-asset risks.[8]
3. Aligning with the Paris agreement's goal of limiting global warming to well below 2°C by the year 2100. This means decarbonizing the index at a rate in line with **reaching net-zero**.

To construct climate-index methodologies, we define net-zero alignment as indexes that follow emission-reduction trajectories that reach net-zero emissions no later than the year 2050 and whose cumulative emissions by 2050 stay within remaining emission budgets. The emission budget defines the temperature a net-zero pathway is aligned with: The lower the temperature, the tighter the budget and the faster the index must decarbonize. MSCI Research has calculated that an annual decarbonization rate of 7% (as proposed by the European Union) is sufficient for the MSCI ACWI IMI to align with a temperature well below 2°C, while a strict 1.5°C temperate alignment requires a decarbonization rate of 10% per year. These two rates are used in different MSCI Climate Indexes.

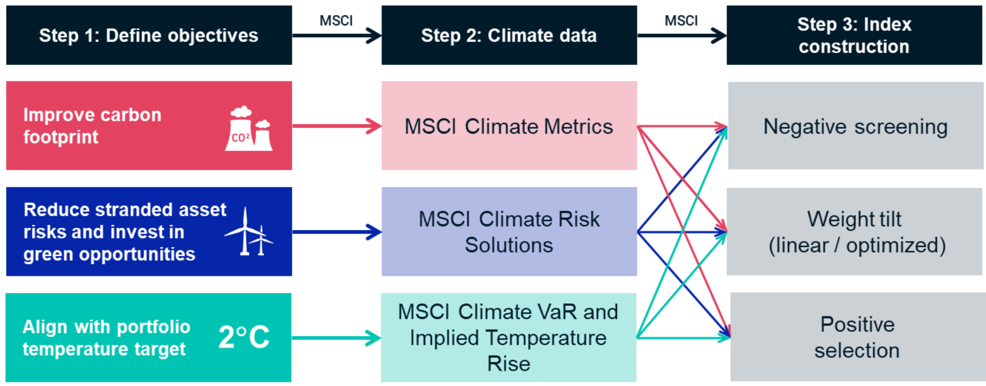
MSCI CLIMATE INDEX-CONSTRUCTION METHODOLOGIES

MSCI has developed different categories of Climate Indexes to address investors' key objectives for mitigating climate-related risks. These indexes use the same climate-related measures that we discussed in the first and second sections of this report, such as emission intensities, fossil-fuel reserves, share of green revenue and Climate VaR.

All the MSCI Climate Indexes follow the three-step index-construction approach summarized in Exhibit 59.

[8] "Net Zero by 2050." International Energy Agency, 2021.

Exhibit 59: MSCI's Three-Step Modular Approach to Creating Climate Indexes



In choosing or creating a climate benchmark, an investor first defines climate-related and financial investment objectives and then maps these objectives to climate-related metrics. Finally, the investor chooses an index-construction approach, based on these metrics.

The choice of objectives, datasets and index methodologies may be assessed using the following questions:

- **Objective:** What is my climate-related investment objective? Do I want to improve my carbon footprint to mitigate stranded-asset risks, or do I want to address transition risks and/or physical risks as well? Do I want to increase my exposure to companies pursuing climate solutions? Do I want to align with a certain temperature target?
- **Index methodology:** Do I want to use sophisticated portfolio optimization techniques to manage the trade-off between climate risk integration and other variables (such as tracking error, country and sector deviations) efficiently? Or do I prefer simple and more transparent index methodologies based on component selection or component reweighting?
- **Breadth:** Do I prefer a broad climate benchmark that keeps most of the opportunity set of the parent index, or do I wish to focus my investments on a smaller number of companies with the highest possible exposure to leaders in the climate transition? Do I seek to divest from companies with the worst emissions footprint, or should I account for those that are setting credible emissions-reduction targets?

We now consider index-construction steps in more depth.

STEP 1: DEFINING OBJECTIVES AND PREFERENCES

There are three broad categories of standard MSCI Climate Indexes, all of which follow strict rules-based approaches and use the MSCI ACWI Index or MSCI ACWI IMI as their starting point. These three categories implement different combinations of the three aforementioned investment objectives.

1. **MSCI Low Carbon Indexes** are focused on one objective: reducing the carbon emissions intensity and lowering exposure to fossil-fuel reserves (which constitute potential future emissions). This approach helps reduce index exposure to potentially stranded assets.
2. **MSCI Climate Change Indexes** combine three objectives: Lowering risk exposure to carbon-intensive companies — including companies exposed through their supply chain (Scope 3 emissions). They also overweight climate solutions opportunities and implement an annual decarbonization rate of 7%, as required by the EU Climate Transition Benchmark regulation and as spelled out in the related delegated act.
3. **MSCI Climate Paris Aligned Indexes** combine the same three objectives as the MSCI Climate Change Indexes but exceed the requirements of the EU Paris-aligned benchmark. They do this by implementing an even stronger shift from fossil-fuel-based companies toward “green” solutions companies and decarbonizing at an annual rate of 10%, aiming to align with a temperature alignment of 1.5°C.

STEP 2: DETAILING DATA USED IN MSCI CLIMATE INDEXES

We provide an overview of the datasets used in the different MSCI Climate Index methodologies in the exhibit below.

Exhibit 60: Data used for MSCI Climate Index categories

Suites and Objectives	MSCI Indexes	MSCI input data used: MSCI ESG data – Controversies/ Business Involvement	MSCI ESG data – Sustainable Impact Metrics (Green revenues)	MSCI Climate Metrics – Fossil Fuel Reserves	MSCI Climate Metrics – GHG Emissions	MSCI Climate Metrics – Low Carbon Transition Score	MSCI Climate Metrics – Climate Value-at-Risk
1. Improve Carbon footprint	• Ex Fossil Fuel • Low Carbon Leaders/Target	✓		✓	✓		
2. Manage climate transition risk	• Climate Change	✓	✓	✓	✓	✓	
3. Paris alignment	• Climate Paris Aligned	✓	✓	✓	✓	✓	✓

MSCI Climate Indexes use MSCI Climate metrics as explained in the methodology section in the introduction to this report. In addition, they use the following ESG datasets:

- **MSCI ESG Controversy Score:** Provides an assessment of controversial events linked to companies and the events' severity for stakeholders and financial relevance. Scores range between zero (very severe) to 10 (no recent incidents). The controversies can also be assessed on individual ESG pillars.
- **MSCI Business-Involvement Screens:** Provides an analysis of the percentage of revenue companies derive from certain business activities, such as alcohol or tobacco production.

STEP 3: CLIMATE INDEX-CONSTRUCTION METHODOLOGIES

All MSCI Climate Indexes follow transparent and rules-based index-construction methodologies that allow for cost-efficient index replication and are based on a standard market-capitalization benchmark. Depending on investor objectives, different climate indexes can be designed using one or more of the following index-construction methodologies:

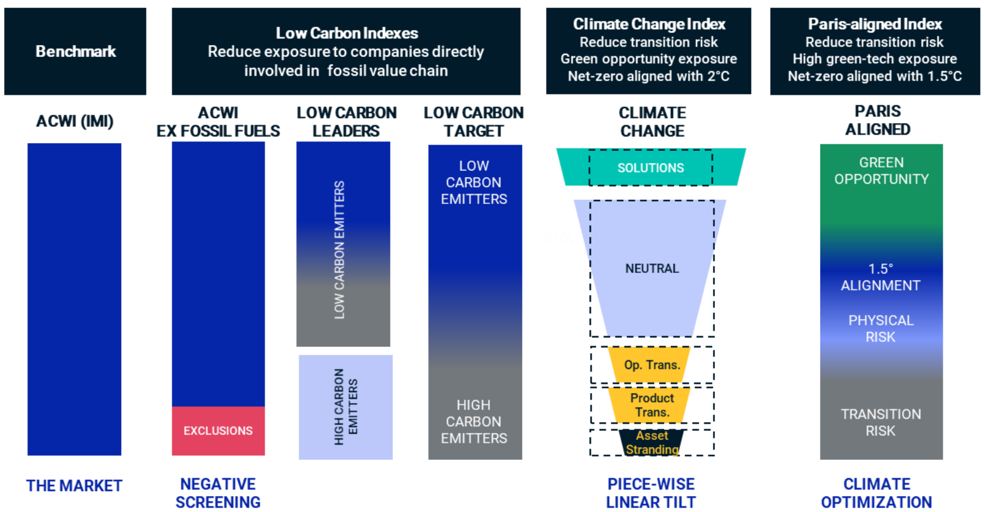
1. **Exclusions** of certain companies from the underlying benchmark universe. The purpose can be to either align with general ESG considerations (divest from controversial activities or when breaches of global norms such as the UN Global Compact occur) or specifically divest from certain fossil-fuel-intensive exposures.
2. **Selection** of companies with superior climate profiles.
3. **Weight tilt** of companies within the benchmark universe toward companies with a superior climate profile.

4. **Optimization** of the climate profile of the index, while controlling for additional climate-related or financial objectives, such as active sector and regional exposures, index turnover or tracking error limits.

MSCI CLIMATE INDEXES

Exhibit 61 summarizes MSCI's three standard Climate Index series.

Exhibit 61: Overview of MSCI Climate Indexes



Gradient fills denote indexes using optimization techniques.

LOW CARBON INDEXES

The **MSCI ex Fossil Fuels Index** is designed for investors who aim to reduce their fossil-fuel-reserves exposure, excluding companies that own oil, gas and/or coal reserves.

MSCI Low Carbon indexes (MSCI Low Carbon Leaders and MSCI Low Carbon Target indexes) reduce climate-transition risks while representing the performance of the broad equity market. These were designed to address two dimensions of carbon exposure: carbon emissions and fossil-fuel reserves, but do not take into account Scope 3 emissions.

MSCI Low Carbon Leaders Index Methodology:

Step	Description
1. Exclude high emitters	Exclude highest 20% (by number) of carbon emitters in terms of Scope 1 and 2 emission intensity (up to 30% benchmark weight per sector can be excluded).
2. Exclude high reserves	Exclude highest fossil-fuel-reserves ownership until 50% of fuel reserves have been excluded from the benchmark.
3. Optimize	Use optimizer to reduce GHG emissions per USD of market cap by at least 50% under active sector exposure, active country exposure and turnover constraints.

MSCI Low Carbon Target Index Methodology:

Step	Description
Optimize climate profile	**Minimize carbon exposure of the index** (defined as carbon-emission intensity and potential emissions per dollar of market capitalization) **Optimization constraints:** • 30 bps ex-ante tracking error • Active sector weight and active country weight • Turnover (one-way) of max. 10% at each index review

MSCI CLIMATE CHANGE INDEX

The MSCI Climate Change Index addresses climate risks and opportunities. The methodology uses the MSCI Low Carbon Transition (LCT) Score and Low Carbon Transition Categories to increase exposure to companies associated with climate-transition opportunities and reduce exposure to those tied to transition risks.

The MSCI Low Carbon Transition Score is a more comprehensive risk measure than emission intensity: The LCT score incorporates Scope 3 emissions (which indicate companies' upstream and downstream climate-transition risks) as well as companies' climate-related management quality. The index is based on a reweighting approach designed to exceed the minimum standards of the EU Climate Transition Benchmark (CTB).[9]

MSCI Climate Change Index Methodology:

Step	Description
1. Exclusions	Excludes companies from the benchmark involved in the manufacturing of controversial weapons, tobacco-related businesses or thermal coal extraction and mining and companies with very severe ESG Controversies or severe environmental controversies.
2. Weight tilt	Company weights are tilted using the MSCI Low Carbon Transition Category (companies in the solutions category are upweighted, while transition-risk categories such as asset stranding and product transition get downweighted). The MSCI Low Carbon Transition Score is used to reweight companies within each category, according to their climate transition profile.
3. Align with net-zero / below 2 °C	Afterward, an additional iterative component reweighting is applied to fulfill the requirements of the EU Climate Transition Benchmark, including an annual self-decarbonization rate of at least 7% per year.

MSCI CLIMATE PARIS ALIGNED INDEXES

The MSCI Climate Paris Aligned Indexes aim to align with a net-zero world. They seek to mitigate climate transition and physical risks, emphasize opportunities arising from the transition to a lower-carbon economy and support the allocation of capital in a way that supports the decarbonization of the economy in line with Paris Agreement requirements. The indexes incorporate the recommendations of the TCFD and are designed to exceed the minimum requirements for the EU Paris Aligned Benchmark.

[9] In the event of changes in the EU-delegated acts (Regulation (EU) 2016/1011 as amended by Regulation (EU) 2019/2089) that mandate an update to the index methodology, MSCI will issue an announcement before implementing the changes. MSCI will not conduct a formal consultation for such an update.

MSCI Climate Paris Aligned Index Methodology: MSCI Climate Paris Aligned Indexes optimize the weights of constituents to achieve these different climate-related objectives.

Step	Description
1. Exclusions	Exclude companies involved in controversial weapons, ESG Controversies, tobacco-related activities, environmental harm, thermal coal mining, oil and gas and power generation from fossil fuels.
2. Optimize climate profile	**Optimize index to improve climate profile:** **1. Reduce transition risk:** • At least 50% reduction of emission intensity (Scopes 1, 2 and 3) • At least 50% reduction in potential emissions • Underweight companies facing transition risk through at least 10% improvement in LCT score • At least 20% overweight in companies with credible emission-reduction targets • Neutral exposure to high-climate-impact sector **2. Invest in green opportunities:** • Weighted average of green revenue over fossil-fuel-based revenue ratio at least four times that of the parent index • Weighted average green revenue at least twice that of the parent index • Overweight companies providing climate solutions through at least a 10% improvement in LCT score **3. Net-zero / 1.5°C temperature alignment** • Annual emission-intensity reduction rate of at least 10% per year • Neutral aggregate Climate VaR under 1.5°C scenario **4. Reduce physical risk** • At least 50% reduction in extreme-weather Climate Value-At-Risk **Additional optimization constraints:** • Active security weight, sector weight and country weight • Limit one-way turnover to 5% at each semiannual rebalance

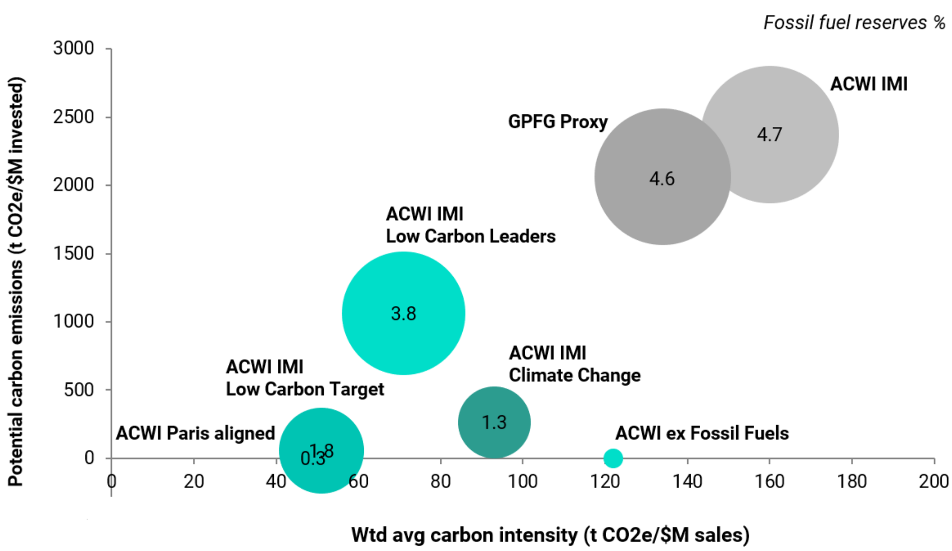
CLIMATE CHARACTERISTICS

To better understand how different MSCI Climate Indexes reflect various investors' climate objectives, we looked at each index along the following dimensions: carbon footprint, fossil-fuel reserves and green versus fossil-fuel-based revenue.

Note: While MSCI Climate Indexes exist as versions based on the MSCI ACWI Index, only MSCI Low Carbon Leaders, MSCI Low Carbon Target and MSCI Climate Change Indexes were calculated in versions for the MSCI ACW IMI at the time of this study. Therefore, we use MSCI ACWI IMI where available, otherwise we used MSCI ACWI-based indexes as a proxy in the following comparisons.

In Exhibit 62, the MSCI Low Carbon Indexes achieved a significant reduction in emissions intensity, potential emissions and weight of fossil-fuel-reserve holding companies compared with the parent index. The MSCI ACWI Climate Paris Aligned Index was the only index achieving an even better footprint than the MSCI Low Carbon indexes.

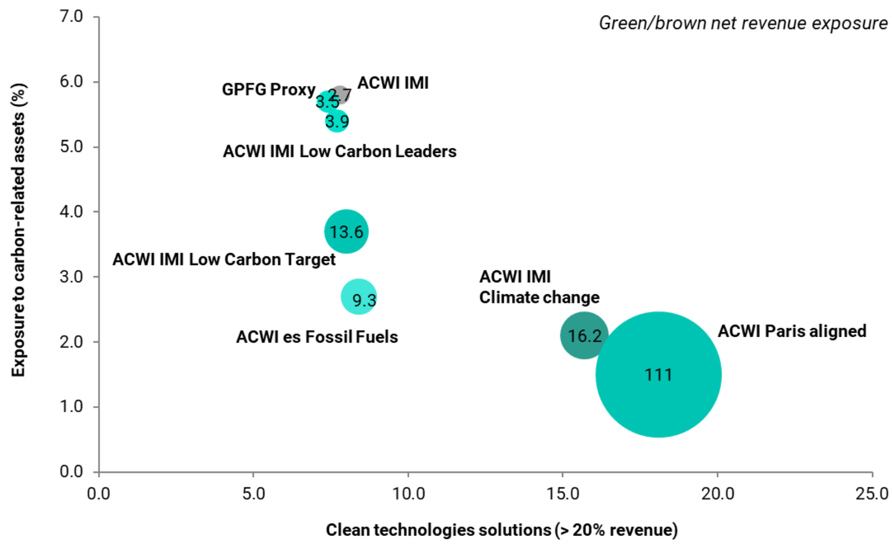
Exhibit 62: Carbon-footprint comparison of MSCI ACWI Climate Indexes



As of June 30, 2021. Bubble sizes represent the weight of companies holding fossil-fuel reserves. Carbon intensity includes Scopes 1 and 2 emissions. Source: MSCI ESG Research LLC

However, when looking at exposure to green technology in Exhibit 63, we see the MSCI ACWI Climate Change Index and especially the MSCI ACWI Climate Paris Aligned Index showing significantly higher exposure to green technology.

Exhibit 63: Fossil-fuel-based vs. green profile of MSCI ACWI Climate Indexes



As of June 30, 2021. Bubble sizes represent the ratio of green versus fossil-fuel-based revenue.
Source: MSCI ESG Research LLC

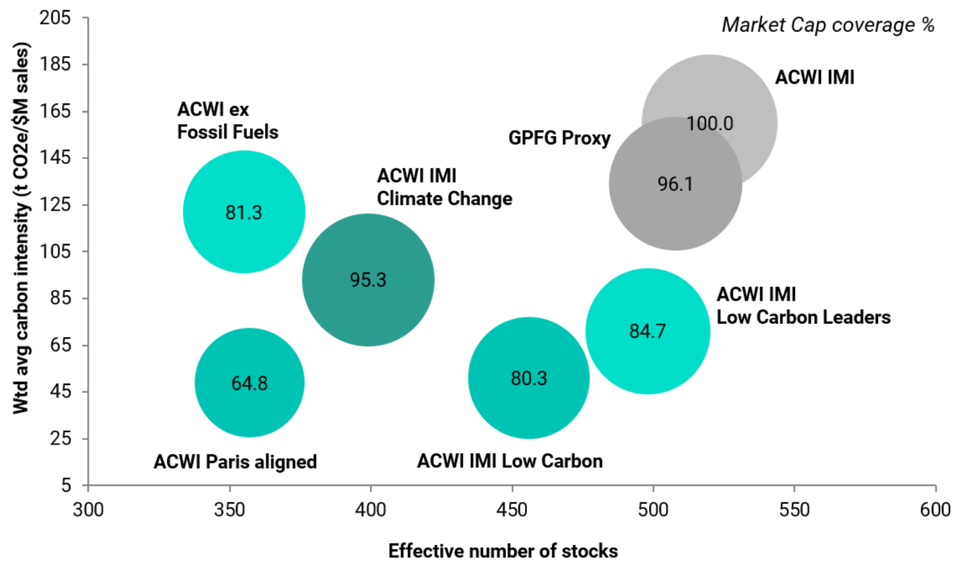
INDEX PROFILE

We now look at the potential climate versus diversification trade-off, as well as the climate versus tracking-error profile of the different MSCI Climate Indexes.

Exhibit 64 looks at the trade-off between achieving an improved carbon footprint versus the impact on diversification (which we measure as the effective number of stocks in the index) and coverage of the underlying market.[10] The MSCI Low Carbon Index series and the MSCI Climate Change Index experienced only slightly lower levels of diversification and market coverage, as of June 30, 2021. The lower coverage levels in the MSCI Climate Paris Aligned Index and the ACWI ex Fossil Fuels Indexes were mainly due to using a smaller base universe (the MSCI ACWI Index instead of the MSCI ACWI IMI).

[10] The effective number of stocks of a portfolio is defined as 1 / Herfindahl index, which is a standard measure for portfolio diversification.

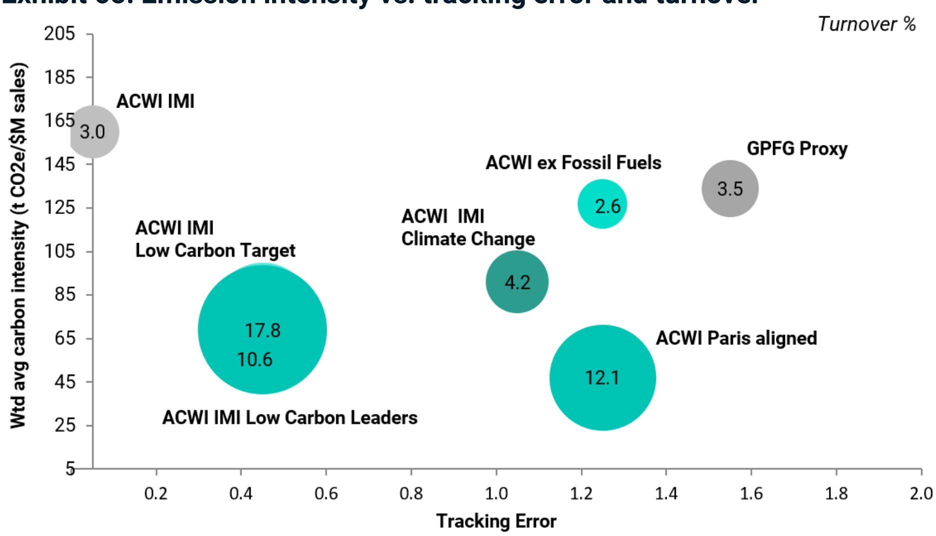
Exhibit 64: Emission intensity vs. diversification and market coverage



As of June 30, 2021. Bubble sizes represent the market coverage of the indexes. Carbon intensity includes Scope 1 and 2 emissions. Source: MSCI ESG Research LLC

Exhibit 65 shows the trade-off between emission intensity versus tracking error and turnover.

Exhibit 65: Emission intensity vs. tracking error and turnover



As of June 30, 2021. Bubble sizes represent the turnover of the indexes. Carbon intensity includes Scope 1 and 2 emissions. Tracking error and turnover were calculated from Nov. 29, 2013, to June 30, 2021. Source: MSCI ESG Research LLC

The MSCI ACWI Low Carbon Leaders Index and the MSCI ACWI Low Carbon Target Index (which are both tracking-error-controlled using an optimization framework) showed very low levels of tracking error and moderate turnover. The MSCI ACWI Climate Paris Aligned Index also controls for tracking error. However, due to more-stringent climate-related optimization constraints, the resulting tracking error was higher.

Climate indexes for large asset owners

We now summarize some of the key findings, looking specifically through the lens of a universal asset owner. They illustrate the trade-offs that assets owners face in using a very broad global equity benchmark, such as MSCI ACWI IMI, versus an index designed to achieve specific climate objectives.

- **Higher index turnover.** Exhibit 60 illustrates that all climate indexes showed higher levels of index turnover than the parent index. This increase in turnover is unavoidable, because all indexes inherit the turnover from the underlying benchmark universe along with additional turnover from changes in climate and ESG characteristics. While this additional turnover may not cause substantial problems for most financial-product providers and asset owners, it may be a concern for very large asset owners such as GPFG.
- **More complex index construction.** Another consideration for many asset owners is transparency of the index-construction methodology. The EU benchmark regulation requirements are quite complex and can only be implemented using advanced index construction methodologies such as optimization — especially if asset owners also want to limit tracking error. However, optimization techniques may reduce transparency because multiple objectives may need to be balanced simultaneously by the models.
- **Lower market coverage.** Exhibit 64 showed that all MSCI Climate Indexes had a reduced level of market coverage. Again, this is necessary to achieve an improvement in climate characteristics. However, this may pose a trade-off to asset owners' active stewardship strategy: Voting and engagement with companies that are perceived as "climate laggards" can be an important strategic component to steer companies toward climate transition. Excluding these companies may considerably reduce the scope of voting and engagement. This means that there is an inherent trade-off between different climate-related investment objectives — i.e., between shifting capital away

from climate laggards and being able to engage with them. In addition, there are financial trade-offs, such as tracking error or turnover considerations, which may be particularly challenging for large asset owners.

Therefore, we will look at customized ways to create climate indexes for managing these trade-offs in the following subsection.

CUSTOMIZED NET-ZERO INDEX STRATEGIES

We seek a customized index-construction methodology that fulfills the key climate objectives and is in line with the recommendations of the different net-zero alliances:

- It should be a net-zero strategy, decarbonizing at an annual rate of at least 7% per year.
- It should not divest from high emitters, to ensure asset owners can still engage with them. Therefore, we will allow for a maximum 75% underweight from the parent index's weight.
- It should shift capital toward green-solutions companies.

In addition, we want to achieve the following index-related objectives to address the trade-offs explained in the previous section:

- The methodology should be simple and rules-based — i.e., without optimization.
- It should limit turnover to low levels.

To achieve these objectives, we followed an index methodology using the GPFG proxy benchmark as of 2021 as the starting universe and taking the following steps to decarbonize the weighted average carbon intensity of the benchmark by at least 7% per year:

- Each year, we sort companies in the universe according to their carbon intensity.
- We lower the weights of the highest emitters by 75% until the index's decarbonization goal of 7% is met.
- We invest the corresponding weight in green-solutions companies (proportional weight increase), as defined by the respective Low Carbon Transition category.

We now simulate this methodology in two ways. The first one only takes into account Scope 1 and 2 emissions, while the second also includes Scope 3 emissions. In the following simulations, we use the GPFG proxy benchmark as of 2021 as the base universe. We also simulate a decarbonization pathway assuming the underlying base universe doesn't change. This means that index-turnover figures in the following examples should be interpreted as turnover beyond the turnover of the benchmark universe.

We highlight that our simluations are based on the assumption that the underlying benchmark does not change during the simluation period, and therefore its emission profile stays the same. If the underlying benchmark changes its emission profile during the simulation period, the simulated decarbonziation may prove more challenging (if benchmark emissions go up) or less challenging (if benchmark emissions go down) than shown in the following simulations.

Decarbonization pathway for Scopes 1 and 2 emissions

Exhibit 66 shows the simluation results for the decarbonization of Scope 1 and 2 emissions intensity in the GPFG proxy benchmark. The first column shows the year since the base year 2021. The Active Share column indicates the weight shifted from high emitters toward green solutions and the Ex Ante Tracking Error estimates the tracking error to the benchmark universe (which remains fixed).

Exhibit 66: Simulated decarbonization pathway for Scope 1 and 2 emissions

Year	Cumulative GHG reduction	Active Share	Turn-over	Effective number of stocks	Ex Ante TE
0	0.0%	0.0%	0.00%	407.8	0.00%
1	7.0%	0.1%	0.09%	405.8	0.02%
2	13.5%	0.2%	0.14%	402.7	0.04%
3	19.6%	0.4%	0.18%	398.7	0.07%
4	25.2%	0.7%	0.28%	392.4	0.12%
5	30.4%	1.1%	0.45%	382.1	0.18%
6	35.3%	1.6%	0.49%	370.6	0.26%
7	39.8%	2.2%	0.60%	356.9	0.36%
8	44.0%	3.0%	0.76%	339.7	0.50%
9	48.0%	3.8%	0.83%	321.7	0.67%
10	**51.6%**	**4.8%**	**1.00%**	**300.0**	**0.83%**
11	55.0%	5.7%	0.92%	281.9	1.02%
12	58.1%	7.0%	1.23%	257.0	1.20%
13	61.1%	9.1%	2.11%	219.9	1.46%
14	63.8%	13.0%	3.88%	165.8	1.89%

Year 0 is the base year (2021). Data as of June 30, 2021. Source: MSCI ESG Research LLC

In the first few years of decarbonization the relative shift in weights (active share), turnover and tracking error, as well as the reduction in diversification, were quite small. However, the financial impact increases after the first five years and accelerates even more after 10 years.

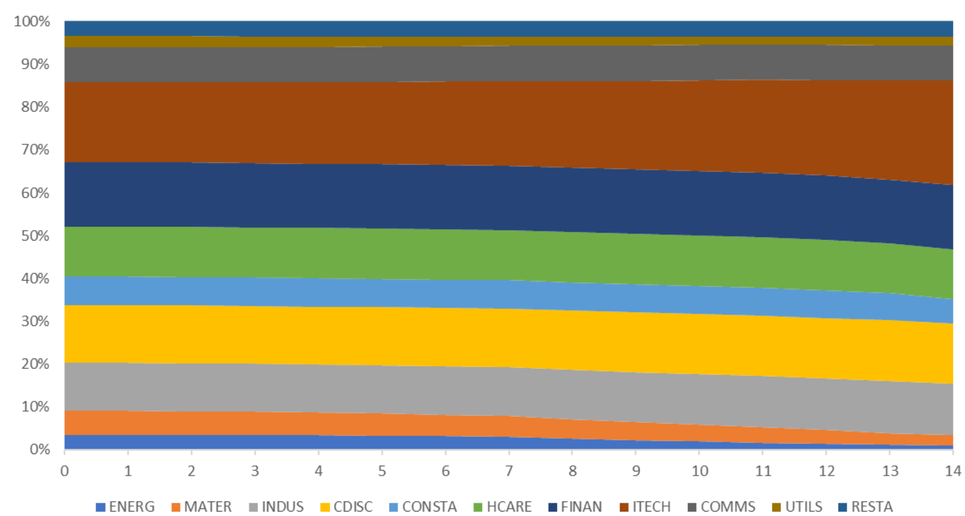
The reason for this is the high level of concentration of emissions and emission intensities in the benchmark universe: Because emissions were very concentrated, to the index could lower the weights of only a few very high emitters at the beginning to achieve a 7% carbon-footprint improvement every year. However, once the highest emitters have seen their weights drop to the full extent, the algorithm needs to lower the weights of an increasing number of emitters every year to achieve a 7% emission reduction. This effect is accompanied by an increasing impact on tracking error, turnover and diversification.

After 14 years, the algorithm is no longer able to decarbonize the benchmark by 7% a year simply by reducing the weights of the high emitters; at this point in the simulation, all high emitters have been underweighted by 75% and a further decarbonization would require a further reduction in weights (or total exclusion) of some of the high emitters.

The key lesson learned from this simulation is that decarbonizing at a fixed rate every year while maintaining a broad, diversified universe of stocks is possible over the long run *only if the underlying universe of stocks is also decarbonizing itself* — that is, the number of high emitters is declining. In such a scenario, the number of stocks whose weights would have to be lowered would shrink, leading to a smaller relative impact on diversification, turnover and tracking error.

Note: We haven't controlled for sectors in this simulation. Exhibit 67 looks at relative sector weights during the simulation.

Exhibit 67: Simulated sector weights



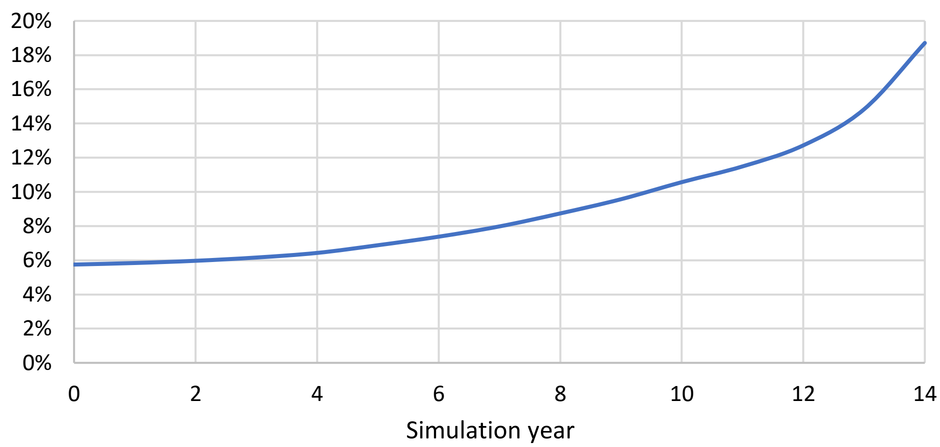
Data as of June 30, 2021. Source: MSCI ESG Research LLC

Again, we observe that during the first five years in our simulation, there was very little shift in sector weights, reflecting that only a few stocks needed to have their weights reduced to achieve the desired decarbonization rate. However, toward the end of the simulation period, the shift in sector weights accelerated and led to much lower weights in the energy and materials sectors.

This means that decarbonization methodologies that aim to control for shifts in sector weights may face even sooner the problem of not being able to decarbonize by simply lowering the weights of components.

In Exhibit 68, we look at the simulated weight of the green-solutions companies, whose weights were sequentially increased in this simulated index. During the simulation, the weight of these companies increased from its current level of 5.8% to almost 19%. In practice, this may lead to capacity issues when investors shift significant amounts of capital from high emitters toward green-solutions companies. However, during the simulation, no constituent in the simulated index reached GPFG’s 10% ownership limit.

Exhibit 68: Simulated weight of green-solutions category



Data as of June 30, 2021. Source: MSCI ESG Research LLC

It is critical to reemphasize that all these results assumed that the underlying benchmark universe does not change. However, if the underlying universe changes over time, some of the observed trade-offs may become more or less severe. For instance, if more and more green-technology companies enter the benchmark universe over time, this would reduce the risk of the investing phenomenon known as “crowding” in scarce green-solutions companies.

Decarbonization pathway for Scope 1, 2 and 3 emissions

The second simulation adds Scope 3 emissions to the analysis of companies' Scope 1, 2 and 3 emission intensities (Exhibit 69).

Exhibit 69: Simulated decarbonization pathway for Scope 1, 2 and 3 emissions

Year	Cumulative GHG reduction	Active Share	Turn-over	Effective number of stocks	Ex Ante TE
0	0.0%	0.0%	0.00%	407.8	0.00%
1	7.0%	0.2%	0.24%	402.4	0.05%
2	13.5%	0.7%	0.50%	391.0	0.14%
3	19.6%	1.4%	0.63%	376.5	0.26%
4	25.2%	2.3%	0.88%	356.9	0.46%
5	30.4%	3.2%	0.96%	337.1	0.67%
6	35.3%	4.2%	1.02%	314.7	0.87%
7	39.8%	5.5%	1.25%	287.1	1.02%
8	44.0%	7.1%	1.59%	255.6	1.25%
9	48.0%	9.2%	2.18%	217.0	1.53%
10	51.6%	**13.0%**	**3.78%**	**164.3**	**1.95%**

Data as of June 30, 2021. Source: MSCI ESG Research LLC

Again, we observed an accelerating impact on turnover, diversification and tracking error over time. However, these financial effects materialized sooner than in the previous simulation. The reason: Scope 3 emissions were less concentrated than Scope 1 and 2 emissions, which means that a continuous decarbonization requires lowering the weights of relatively more stocks than in the previous simulation. As a consequence, the simulation fails after 10 years; after that, a further decarbonization would require reducing the weights of high emitters by more than 75% — or even a total exclusion of high emitters. During the simulated period, no constituent reached GPFG's 10% ownership limit.

Trade-offs in building decarbonization pathways

It is important to highlight the two types of trade-off that asset owners face when building decarbonization pathways.

To start, there is a conceptual trade-off between the idea of holding the entire market (which maximizes the accessible opportunity set) and reflecting climate considerations in their benchmark, either because investors want to incentivize positive impact or because they want to reflect long-term risk and opportunities in their benchmark that may not be fully priced in today due to high levels of uncertainty.

In addition, there are practical trade-offs in implementing climate risk in benchmarks.

The first practical trade-off is between different climate-related objectives. The Net-Zero Asset Owner Alliance recommends implementing decarbonization pathways, financial green solutions and voting and engagement. However, our simulations showed that asset owners employing decarbonization pathways may face trade-offs between these objectives: To continuously decarbonize, an index may at some point require divesting from high emitters, which prevents engagement with these emitters.

The second practical trade-off is between achieving climate-related objectives (decarbonizing, shifting capital toward green solutions) and financial objectives such as diversification and turnover. At present time, the opportunity set for investing in climate solutions within listed-equity markets is relatively small and may lead to concentrated positions in these companies.

Both trade-offs can occur only if the decarbonization pathway aims to decarbonize faster than the underlying benchmark, in which case both trade-offs increase over time.

However, in a world in which the underlying benchmark itself decarbonizes at the desired rate, investors face no practical trade-offs.

Conclusion

The Paris Agreement set the objective to cut emissions to limit global warming to well below 2°C. This requires global listed companies to decarbonize accordingly. However, we found that the absolute level of emissions in global equity markets has been increasing since the agreement was signed in 2015, which means that companies in aggregate haven't really started the necessary economic transition. Therefore, investors may need to expect that most of the "creative destruction" may lie ahead of us. This may pose severe financial transition risks and opportunities for investors. However, not implementing the Paris Agreement would expose companies and humankind to severe physical risks in the long run.

We simulated possible scenarios but emphasize that there is a very high level of uncertainty in climate models in general and climate-risk models in particular, where possible developments are not entirely known and probability distributions cannot be estimated. Therefore, investors need to be cautious in addressing climate risks in the same way as market or credit risks, where future outcomes and related probability distributions are well-understood and efficient markets can be assumed to price in known information efficiently.

The digital revolution of the past three decades poses a serious challenge for financial risk managers who need to model the financial impact of climate risks, given the level of uncertainty, long horizon and lack of understanding of the probability distributions of climate risks. We found some evidence of a repricing of equities in the past few years, in terms of valuation levels and cost of capital, other equity factors being equal. This means a period of repricing of assets based on climate-change considerations may already be underway.

Climate risk's high level of uncertainty is also revealed in the relative importance of transition risk and physical risk: Transition risks may be most severe if the world decarbonizes quickly, while physical risks may be most severe if the world does not decarbonize at all.

Following the recommendations of organizations such as the TCFD, investors can look at emission intensities, which measure how exposed companies' business models are to transition risks. We observed an overall decline in GPFG's emission intensity, mainly due to an increase in corporate sales and a relative shift in benchmark weights from emission-intensive sectors toward less intensive sectors. This shift suggests a "market-implied" move away from assets highly exposed to transition risk. We also saw that emerging markets were clearly more emission-intensive, which may expose them to an increased level of transition risk going forward.

The TCFD also recommends using more forward-looking risk measures such as implied temperature rise, which showed that the most emission-intensive sectors were also the ones that face the greatest challenges in aligning themselves to net-zero pathways. We also found emerging markets to be less aligned with net-zero pathways than developed markets, reemphasizing the potentially higher levels of transition risks for emerging markets.

Scenario analysis is another methodology proposed by the TCFD to simulate future decarbonization pathways and their potential financial impact without trying to estimate these outcomes' probabilities.

The highest projected climate transition costs for reaching net-zero were found in the most carbon-intensive sectors — i.e., energy, materials and utilities. The size of the estimated costs suggests that many companies in these sectors may require fresh capital to finance their transition to net-zero, highlighting the important role that investors have to play.

A key question for investors is to what extent they wish to reflect climate change in their benchmarks. GPFG's investment objective is focused on financial results, and the Norwegian Ministry of Finance has chosen an equity benchmark that is based on a global market-cap-weighted index. ESG and climate indexes are based on broad market-cap indexes, but they typically exclude some companies and/or reweight companies to achieve ESG- or climate-related investment objectives.

Compared with the broad market, these indexes tend to be less diversified, show higher index turnover and have more complex index methodologies. Higher turnover and transaction costs are especially relevant for large asset owners such as GPFG. In addition, some climate benchmarks may also face investment capacity issues, as there is a limited number of green-solutions companies. In contrast to market-cap-weighted indexes, the methodology used in constructing climate benchmarks has evolved rapidly in recent years and may continue to evolve.

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Appendix

REGRESSION ANALYSIS OF VALUATION AND COST OF EQUITY

We looked at the impact of Scope 1 and 2 emission intensity on the cost of equity and price-to-book ratio. To be precise, we regressed price-to-book and cost of equity versus the log of emission intensity using sectors, regions, size, profitability, growth, momentum, residual volatility, oil-price sensitivity and earnings variability as control variables.

In Exhibit A1, we observe a small but decreasing regression coefficient for price-to-book, meaning more emission-intensive companies saw their valuation levels decline during the study period, after controlling for other factors. At the same time, their cost of equity increased.

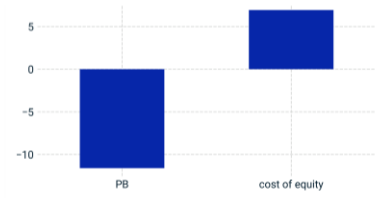
We note that while both regression coefficents were relatively small, the significance as measured by R^2 increased during the study period, providing empirical evidence that financial markets increasingly took into account companies' emissions profile in pricing equities.

Exhibit A1: Regression coefficent of emission intensity (left) and R2 (right)

Period from Oct. 31, 2014, to June 30, 2021. Source: MSCI ESG Research LLC

This observation is confirmed when looking at the statistical significance of the trend of price-to-book and cost of equity in Exhibit A2: Both the change in price-to-book and cost-of-equity levels showed a statistically significant t-stat.

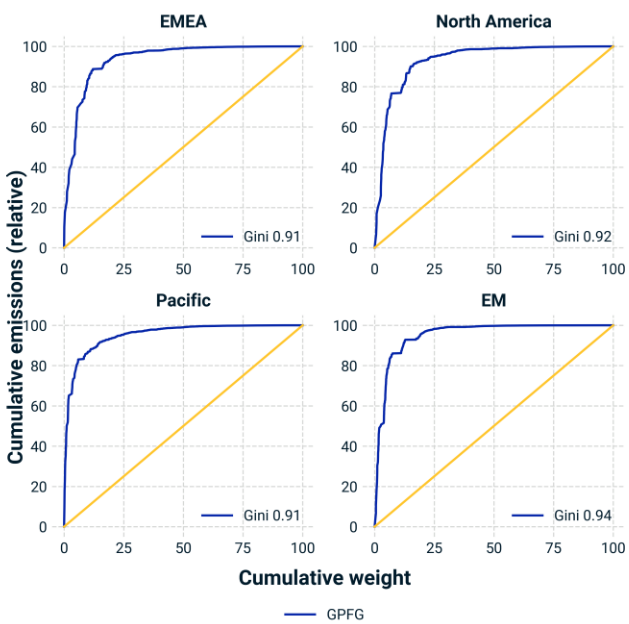
Exhibit A2: T-stat of trend in price-to-book and cost of equity regression coefficient



Period from Oct. 31, 2014, to June 30, 2021. Source: MSCI ESG Research LLC

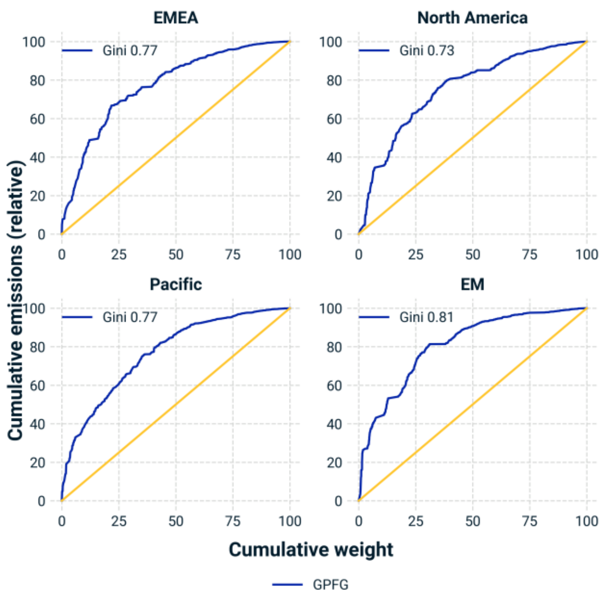
REGIONAL-CONCENTRATION LORENZ CURVES

Exhibit A3: Regional Lorenz curve of companies' scope 1 emissions



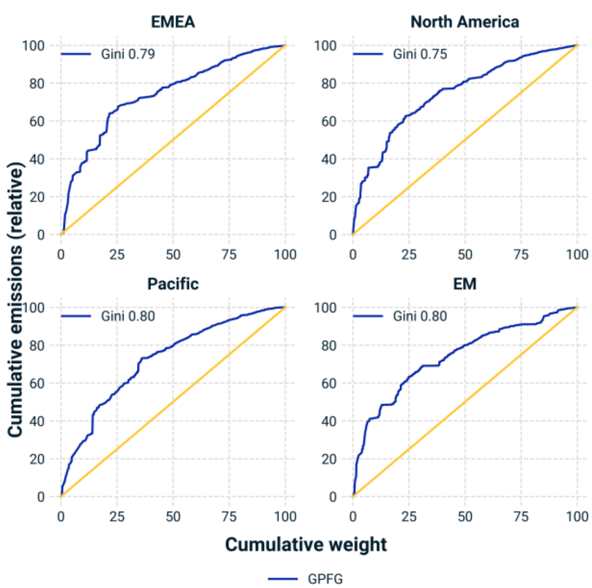
Data as of June 30, 2021. Source: MSCI ESG Research LLC

Exhibit A4: Regional Lorenz curve of companies' Scope 2 emissions



Data as of June 30, 2021. Source: MSCI ESG Research LLC

Exhibit A5: Regional Lorenz curve of companies' Scope 3 emissions



Data as of June 30, 2021. Source: MSCI ESG Research LLC

Exhibit A6: Largest five emitters by region

	Emissions (Mt)	Cumulative emissions (% of GPFG proxy)	Country	GICS sector	Region
ARCELORMITTAL SA	174	5.13	FRANCE	Materials	EMEA
LAFARGEHOLCIM	121	13.44	SWITZERLAND	Materials	EMEA
ENEL SPA	95	19.76	ITALY	Utilities	EMEA
HEIDELBERGCEMENT AG	77	23.72	GERMANY	Materials	EMEA
ROYAL DUTCH SHELL PLC	70	24.59	UNITED KINGDOM	Energy	EMEA
EXXON MOBIL CORPORATION	116	14.88	USA	Energy	North America
SOUTHERN CO	102	16.15	USA	Utilities	North America
VISTRA ENERGY CORP	79	22.77	USA	Utilities	North America
CHEVRON CORP	59	28.43	USA	Energy	North America
BERKSHIRE HATHAWAY INC	59	29.15	USA	Financials	North America
NIPPON STEEL CORPORATION	95	18.59	JAPAN	Materials	Pacific
TOKYO ELECTRIC POWER COMPANY HLDS INC	82	20.78	JAPAN	Utilities	Pacific
CHUBU ELECTRIC POWER CO INC	53	33.23	JAPAN	Utilities	Pacific
JFE HOLDINGS INC	52	33.87	JAPAN	Materials	Pacific
TOHOKU ELECTRIC POWER CO INC	36	43.31	JAPAN	Utilities	Pacific
GAZPROM PAO	240	2.98	RUSSIA	Energy	EM
GD POWER DEVELOPMENT CO LTD	147	6.96	CHINA	Utilities	EM
ANHUI CONCH CEMENT CO LTD	146	8.77	CHINA	Materials	EM
PETROCHINA CO LTD	129	10.38	CHINA	Energy	EM
CHINA PETROLEUM & CHEMICAL CORP	126	11.94	CHINA	Energy	EM

Data as of June 30, 2021. Source: MSCI ESG Research LLC

ATTRIBUTION OF TRENDS IN EMISSIONS INTENSITY

We use a Brinson attribution technique to attribute differences in average emissions intensity between portfolios.

The Brinson attribution technique starts with the definition of groups (buckets) of stocks, based on sectors and regions. Then it breaks down emissions-intensity differences into three components: allocation, selection and interaction terms. The allocation term describes the effect of over/underweighting buckets relative to the benchmark. For example, the overweighting of a more carbon-intensive bucket has a positive contribution to the portfolio's average intensity. The selection term describes the effect of reweighting stocks inside a bucket. For example, underweighting or excluding more emission-intensive stocks from a bucket leads to a negative selection contribution. Finally, the interaction term describes the nonlinear interaction between allocation and selection effects.

We used 44 buckets defined by the intersection of the 11 GICS sectors and four regions.

The attribution terms are calculated as follows:

Allocation: $\sum_i w_i^A \left(C_i^B - C^B \right)$

Selection: $\sum_i w_i^B \left(C_i^P - C_i^B \right)$

Interaction: $\sum_i w_i^A \left(C_i^P - C_i^B \right)$

Notations: w_i^X= weight of bucket *i*, C_i^X=carbon intensity of bucket *i*, superscripts *X* = *B*, *P* or *A* refer to the benchmark, portfolio and active, respectively. C^B denotes the average intensity of the benchmark.

Exhibit A7: Details on GPFG emissions-intensity change attribution

GPFG proxy benchmark scope 1&2 emissions intensity change - Allocation - 5y

	EMEA	North America	Pacific	EM	Sector total
Energy	-1.1	-4.2	-0.8	-0.2	-6.3
Materials	-1.5	-0.7	-0.3	2.9	0.3
Industrials	-0.2	-0.0	0.1	0.0	-0.1
Consumer Discretionary	0.4	-0.2	0.5	-1.7	-1.0
Consumer Staples	1.5	1.1	0.3	0.1	2.9
Health Care	1.4	-0.4	0.1	-0.5	0.6
Financials	3.6	2.1	2.3	0.8	8.7
Information Technology	-1.1	-6.1	-0.2	-0.3	-7.7
Communication Services	0.5	-3.8	-0.0	-0.7	-4.0
Utilities	-1.7	-6.7	-1.2	0.1	-9.5
Real Estate	-0.7	-0.7	-0.5	-0.3	-2.3
Region total	1.1	-19.7	0.3	0.2	-18.2

GPFG proxy benchmark scope 1&2 emissions intensity change - Selection - 5y

	EMEA	North America	Pacific	EM	Sector total
Energy	0.8	3.1	-0.8	1.6	4.6
Materials	-3.7	-1.3	-2.5	0.7	-6.7
Industrials	-2.1	-0.4	-1.2	0.7	-3.1
Consumer Discretionary	-0.5	-0.2	-0.1	-0.1	-0.8
Consumer Staples	-1.2	-0.0	-0.1	0.2	-1.1
Health Care	-0.7	-0.2	-0.0	0.1	-0.8
Financials	-0.6	-2.4	-1.4	-0.5	-5.0
Information Technology	-0.1	-0.3	0.1	1.5	1.2
Communication Services	-0.1	-0.5	-0.1	-0.4	-1.1
Utilities	-2.6	-7.0	0.0	0.4	-9.2
Real Estate	0.0	0.0	0.0	0.0	0.0
Region total	-10.9	-9.2	-6.1	4.3	-22.0

GPFG proxy benchmark scope 1&2 emissions intensity change - Interaction - 5y

	EMEA	North America	Pacific	EM	Sector total
Energy	-0.4	-1.6	0.3	-0.2	-1.8
Materials	0.3	0.1	0.1	0.3	0.8
Industrials	-0.1	-0.0	0.2	0.0	0.1
Consumer Discretionary	0.0	-0.0	0.0	-0.1	-0.0
Consumer Staples	0.4	0.0	0.0	-0.0	0.4
Health Care	0.2	-0.0	0.0	0.1	0.3
Financials	0.2	0.6	0.7	0.1	1.6
Information Technology	-0.0	-0.2	0.0	0.2	0.0
Communication Services	0.0	-1.6	-0.0	-0.4	-2.0
Utilities	0.5	1.9	-0.0	0.0	2.4
Real Estate	0.0	0.0	0.0	0.0	0.0
Region total	1.1	-0.8	1.4	0.0	1.7

GPFG proxy benchmark scope 1&2 emissions intensity change - Active weight % - 5y

	EMEA	North America	Pacific	EM	Sector total
Energy	-1.3	-1.6	-0.1	-0.1	-3.0
Materials	-0.2	-0.1	-0.0	0.2	-0.2
Industrials	0.2	0.1	-0.4	0.0	0.0
Consumer Discretionary	-0.3	0.2	-0.4	1.4	0.8
Consumer Staples	-1.6	-1.1	-0.3	-0.1	-3.0
Health Care	-1.2	0.3	-0.0	0.4	-0.5
Financials	-2.3	-1.9	-1.9	-0.6	-6.6
Information Technology	0.8	4.4	0.2	0.4	5.7
Communication Services	-0.4	3.5	0.0	0.8	4.0
Utilities	-0.3	-0.3	-0.1	0.0	-0.7
Real Estate	0.8	1.5	0.8	0.4	3.5
Region total	-5.7	5.1	-2.3	2.9	0.0

Data as of June 30, 2021. Source: MSCI ESG Research LLC

CALCULATION OF IMPLIED TEMPERATURE RISE

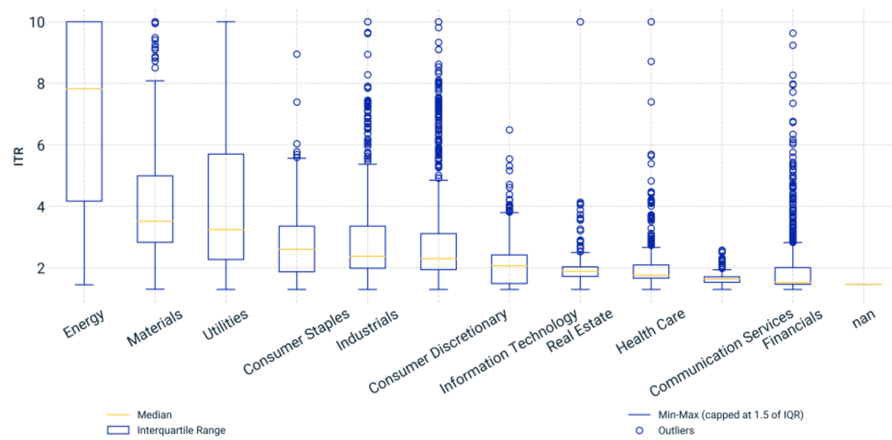
The calculation of companies' Implied Temperature Rise is based on their remaining emissions budgets and estimated future emissions overshoot or undershoot of the budget. The relative overshoot is defined as the absolute emissions overshoot divided by the remaining emissions budget.

The so-called Transient Response to Cumulative CO2 Emissions (TCRE) formula is used to link relative budget overshoots to temperature rise (Exhibit A8). This is based on the discussion in the TCFD's Technical Supplement (2021c) and derived from IPCC (2013).

Exhibit A8: TCRE formula

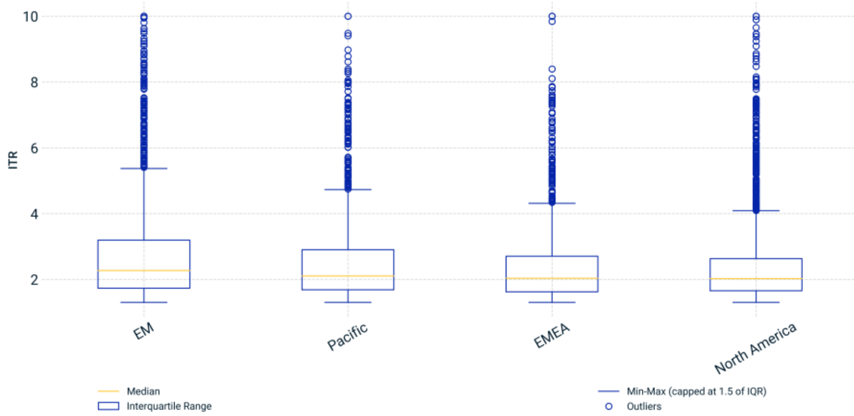
$$T = 2℃ + \frac{\textit{Company Carbon Budget Overshoot}}{\textit{Company Carbon Budget}} \cdot \textit{Global Carbon Budget} \cdot 0.000545℃/GtCO2$$

Exhibit A9: Distribution of Implied Temperature Rise in GPFG sectors



*Data as of June 30, 2021. The plot shows median values of Implied Temperature Rise (yellow line) and the interquartile range (IQR), defined as the range Q3-Q1 between the 25th percentile Q1 and 75th percentile Q3 (blue box), as well as the winsorized minimum and maximum range from Q1 – 1.5 * IQR to Q3 + 1.5 * IQR (blue lines). Source: MSCI ESG Research LC*

Exhibit A10: Distribution of Implied Temperature Rise in GPFG regions



*Data as of June 30, 2021.The plot shows median values of Implied Temperature Rise (yellow line) and the interquartile range (IQR), defined as the range Q3-Q1 between the 25th percentile Q1 and 75th percentile Q3 (blue box), as well as the winsorized minimum and maximum range from Q1 – 1.5 * IQR to Q3 + 1.5 * IQR (blue lines). Source: MSCI ESG Research LLC*

ATTRIBUTION ANALYSIS OF IMPLIED TEMPERATURE RISE

Most of the difference in Implied Temperature Rise between the GPFG proxy benchmark and the ACWI IMI was due to allocation effects (xhibit A11). Overall, the single largest effect was the underweighting of the North American energy sector.

Exhibit A11: Attribution of GPFG Implied Temperature Rise versus ACWI IMI

GPFG proxy benchmark ITR versus ACWI IMI - Allocation

	EMEA	North America	Pacific	EM	Sector total
Energy	0.02	-0.07	0.00	0.00	-0.05
Materials	0.02	-0.01	0.00	-0.00	0.01
Industrials	-0.01	0.00	0.00	-0.00	-0.01
Consumer Discretionary	0.02	0.00	0.00	0.00	0.02
Consumer Staples	-0.01	0.01	-0.00	0.00	0.00
Health Care	-0.01	0.03	-0.00	-0.00	0.01
Financials	-0.03	0.02	-0.00	-0.00	-0.02
Information Technology	-0.01	0.02	-0.00	-0.00	0.01
Communication Services	-0.01	0.01	-0.00	-0.00	0.00
Utilities	-0.00	-0.01	0.00	-0.01	-0.02
Real Estate	-0.00	0.00	-0.00	-0.00	0.00
Region total	-0.03	0.00	-0.00	-0.01	-0.04

GPFG proxy benchmark ITR versus ACWI IMI - Active weight

	EMEA	North America	Pacific	EM	Sector total
Energy	1.81	-1.56	0.03	0.05	0.33
Materials	1.38	-0.93	0.18	-0.40	0.23
Industrials	2.73	-2.29	0.30	-0.00	0.74
Consumer Discretionary	2.55	-1.65	0.23	0.13	1.27
Consumer Staples	1.31	-1.97	0.08	-0.06	-0.64
Health Care	1.10	-1.84	0.06	0.02	-0.66
Financials	2.15	-1.44	0.09	0.08	0.88
Information Technology	0.62	-1.65	0.10	0.21	-0.71
Communication Services	0.46	-0.77	0.05	0.04	-0.21
Utilities	0.72	-1.25	-0.26	-0.35	-1.16
Real Estate	0.06	-0.18	0.03	0.02	-0.07
Region total	14.91	-15.53	0.89	-0.27	-0.00

Data as of June 30, 2021. Source: MSCI ESG Research LLC

ATTRIBUTION ANALYSIS OF CLIMATE-RISK COSTS

We used a Brinson attribution to attribute differences in climate-risk costs between the GPFG proxy benchmark and MSCI ACWI IMI into allocation and selection effects (Exhibits A12 and A13). The interaction effect was negligible in both cases. It is important to mention that for both climate-transition risk and physical risk, the risk in the GPFG proxy benchmark was higher due to allocation effects. The strongest contributor in both risk measures was the relative underweight in the North American information technology sector, which showed low levels of climate risk, and therefore the relative underweight led to a relative increase in risk in the GPFG proxy benchmark. At the same time, the relative overweight in EMEA materials, energy and utilities also increased the relative risk of the GPFG proxy benchmark.

Exhibit A12: GPFG transition climate VaR versus ACWI IMI – Attribution breakdown

GPFG proxy benchmark delayed transition CVAR versus ACWI IMI - Allocation

	EMEA	North America	Pacific	EM	Sector total
Energy	-0.25	0.28	-0.00	-0.02	0.00
Materials	-0.35	0.12	-0.02	0.05	-0.19
Industrials	0.12	0.02	0.02	-0.00	0.15
Consumer Discretionary	-0.06	-0.09	0.05	0.02	-0.07
Consumer Staples	-0.12	0.16	-0.01	-0.00	0.03
Health Care	0.11	-0.10	0.01	0.01	0.02
Financials	0.02	-0.09	0.01	0.01	-0.05
Information Technology	0.10	-0.34	0.03	0.03	-0.19
Communication Services	-0.10	-0.07	0.00	0.01	-0.16
Utilities	-0.12	0.31	0.00	0.01	0.20
Real Estate	0.02	-0.02	0.01	0.00	0.01
Region total	-0.62	0.16	0.10	0.11	-0.24

GPFG proxy benchmark delayed transition CVAR versus ACWI IMI - Selection

	EMEA	North America	Pacific	EM	Sector total
Energy	-0.00	0.03	0.00	-0.01	0.03
Materials	0.04	-0.02	0.00	-0.02	0.00
Industrials	-0.04	-0.12	-0.00	0.01	-0.15
Consumer Discretionary	-0.00	0.00	-0.00	0.00	0.00
Consumer Staples	-0.02	0.04	-0.01	0.01	0.02
Health Care	0.00	0.00	-0.00	-0.00	0.00
Financials	-0.00	0.00	-0.00	-0.01	-0.01
Information Technology	0.00	0.00	0.00	-0.00	-0.00
Communication Services	-0.01	-0.00	0.00	-0.00	-0.01
Utilities	0.01	0.16	0.02	0.03	0.21
Real Estate	-0.00	0.00	-0.00	-0.00	-0.00
Region total	-0.03	0.11	0.01	0.01	0.10

Data as of June 30, 2021. Source: MSCI ESG Research LLC

Exhibit A13: GPFG physical climate VaR versus ACWI IMI – Attribution breakdown

GPFG proxy benchmark phyiscal var (aggressive) versus ACWI IMI - Allocation

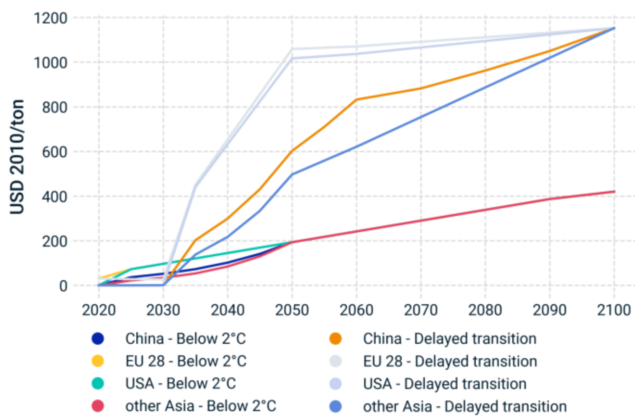
	EMEA	North America	Pacific	EM	Sector total
Energy	-0.08	0.02	-0.00	-0.00	-0.06
Materials	0.03	-0.02	-0.01	0.01	0.02
Industrials	0.09	-0.05	-0.04	-0.01	-0.00
Consumer Discretionary	0.06	-0.09	-0.02	0.00	-0.06
Consumer Staples	-0.06	0.09	-0.01	-0.00	0.02
Health Care	0.08	-0.08	0.00	0.00	0.00
Financials	-0.22	-0.01	-0.02	-0.01	-0.27
Information Technology	0.09	-0.28	0.00	-0.01	-0.20
Communication Services	-0.09	-0.05	-0.01	-0.00	-0.15
Utilities	-0.10	0.17	0.00	0.01	0.09
Real Estate	-0.01	-0.00	-0.02	-0.00	-0.03
Region total	-0.21	-0.31	-0.11	-0.02	-0.64

GPFG proxy benchmark phyiscal var (aggressive) versus ACWI IMI - Selection

	EMEA	North America	Pacific	EM	Sector total
Energy	-0.00	-0.01	-0.00	-0.00	-0.02
Materials	0.00	-0.00	0.00	-0.02	-0.01
Industrials	0.01	-0.01	0.00	-0.00	-0.01
Consumer Discretionary	-0.00	-0.00	0.00	-0.00	-0.00
Consumer Staples	-0.00	0.01	-0.00	0.00	0.01
Health Care	0.00	0.00	-0.00	-0.00	0.00
Financials	-0.00	0.00	0.00	-0.02	-0.02
Information Technology	-0.00	0.00	0.00	-0.00	-0.00
Communication Services	-0.00	-0.00	0.00	0.00	0.00
Utilities	-0.00	-0.06	0.00	0.02	-0.04
Real Estate	0.00	0.00	0.00	0.00	0.00
Region total	0.00	-0.08	-0.00	-0.02	-0.10

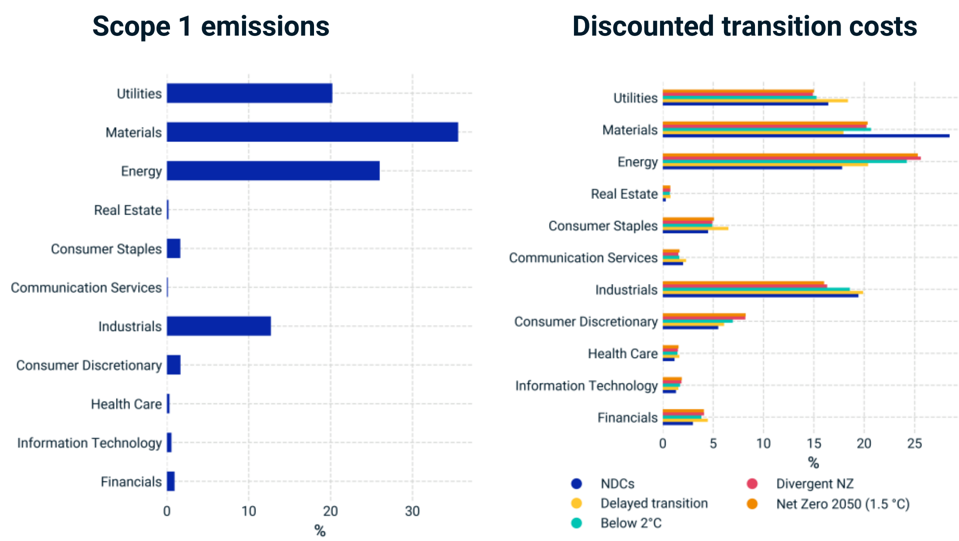
Data as of June 30, 2021. Source: MSCI ESG Research LLC

Exhibit A14: Projected carbon prices



Source: Network for Greening the Financial System

Exhibit A15: Share of gross transition costs and Scope 1 emissions by sector (in GPFG benchmark)



Data as of June 30, 2021. Source: MSCI ESG Research LLC

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