MEKETA

Greenhouse Gas Emissions: Consistency Among Data Providers

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CONTRIBUTORS
SARAH BERNSTEIN, PH.D, FSA
SABINA PANTHI, CFA
INWOO HWANG
MATTHEW PARLA
ZAN HAQ, INTERN

Executive summary

Overview

In 2024, Meketa's research team provided thought leadership on a variety of topics related to risk. These topics have included topics such as concentration risk with our research "The Magnificent Seven", country specific risk "Emerging Market Equities without China" or regulatory risk "Treasury Market Regulatory Reforms".

In our most recent sustainability research on Greenhouse Gas Emissions: Consistency Among Data Providers, we look at risks related to data and sustainability. ESG factors, which include Environmental, Social, and Governance considerations, present investment risks because they can have implications for the long-term risk and return of an investment. While these factors might not be reflected in traditional financial statements, they are increasingly recognized as having the potential to affect the financial performance and sustainability of companies. For instance, environmental issues such as climate change and pollution can lead to regulatory fines, reputational damage, and operational disruptions. Social issues like labor standards and community relations can impact employee productivity and brand value. Governance issues such as board composition and executive compensation can influence decision-making and company oversight. Therefore, ESG factors are considered in investment decision-making to evaluate and mitigate potential risks that could affect the financial outcomes of investments.

Summary

As Greenhouse Gas ("GHG") emissions have come into focus for some Chief Investment Officers, trustees, and other stewards of capital, questions have emerged about the available emissions data. Who are the emissions data provider(s)? What are the important differences between data providers? Why are companies struggling to report data? What are our investment risks as it relates to changing climate conditions? Changes to the regulatory requirements surrounding emissions data continue to heighten the importance of these questions and highlight the evolving landscape of industry best practices and legal requirements.[1]

To help answer these questions, Meketa conducted a survey of seven climate data providers. We asked each provider for their 2021 GHG emissions on the securities in the S&P 500 Index and the MSCI All Country World Index ("MSCI ACWI").

Scope 3 emissions are the most difficult to determine because they include indirect emissions from a company's suppliers and from products and services after sale. Scope 1 covers direct emissions and Scope 2 comprises indirect emissions from purchased energy. GHG emissions data serve as a foundation for multiple climate metrics including carbon footprint, carbon efficiency, carbon intensity, implied temperature rise, transition value at risk, carbon budget, avoided emissions, and net zero progress. GHG emissions metrics are a defining element of green revenue share and green capex measures.

Key findings

Our survey found that each data provider may have distinct emission estimates for companies that may under-report or do not report emissions, while they have substantially similar emissions results for company-reported emissions data.

Total emissions, and shares of Scope 1, 2, and 3 emissions were roughly similar for these seven providers and every provider had less company reported data for Scope 3 than Scopes 1 and 2. Scope 3 emissions represented the largest share of emissions (83%-88%), compared to Scope 1 (9%-15%) and Scope 2 (1%-3%). Because larger firms tend to report more climate data, the percentage of reported emissions was closer among providers by market share than by number of companies.

We found the highest consistency among these seven providers for S&P 500 Scope 1 and 2 emissions, where the percentage of company-reported data was highest. The weakest correlations were found for the MSCI ACWI Scope 3 emissions where company-reported data was lowest. Like correlations among providers, the greatest commonality among providers' top 15 emitters was for the S&P 500 Scope 1 and 2.

Index	Correlations among data providers		Number of top 15 emitters in common among data providers	
	Scope 1 and 2	Scope 3	Scope 1 and 2	Scope 3
S&P 500	100%	73% - 99%	12	10
MSCI ACWI	77% - 99%	42% - 89%	9	3

FIGURE 1
GHG Emissions Consistency among Data Providers

Source: Meketa Investment Group, 2024.

We found a revenue bias in every provider's estimate of Scope 3 emissions that was not found consistently across provider's Scope 1 or Scope 2 estimates. Each provider's correlations between estimated Scope 3 emissions and revenues were higher than for reported emissions. For Scope 3, providers often estimate company Scope 3 emissions by adjusting industry Scope 3 emissions using company revenues as a key element. **A revenue bias could potentially lead to investing in lower revenue companies when attempting to invest in lower carbon emitters. Further, it could also result in misleading comparisons of GHG emissions between companies and create emissions inconsistencies over time due to inflation.**

Conclusions

The variation among data providers even on securities in widely used benchmarks indicates that total emissions of portfolios may be different due in part to data provider GHG emissions estimates rather than just security holdings. Depending on the data provider, the estimated emissions could vary. Scope 3 emissions represent most corporate emissions. They are the most difficult to estimate and have the least reported data from companies. At this juncture, treating Scope 3 emissions separately from Scopes 1 + 2 emissions may improve investor use of Scope 1, 2, and 3 data. Similarly, metrics that incorporate GHG emissions such as carbon intensity may be best analyzed separating Scope 1 and 2 emissions intensity from Scope 3 intensity. Additional granularity on Scope 3 upstream and downstream emissions, along with additional climate metrics may further enhance investor understanding of the energy transition risks and opportunities that companies represent.

Investor interest continues to spur more corporations to report climate information and to support broader availability of reliable climate data. Voluntary climate reporting is increasing in corporate public and private markets. Technologies such as machine learning and satellite monitoring of emissions are reducing costs and increasing the number of companies that report emissions. New climate metrics continue to be developed, including more forward-looking energy transition metrics and climate data analytic tools are improving.[2] Over time, we expect climate disclosure regulations[3] to yield more and more harmonized corporate climate data reporting.

We thank the firms that made this comparison possible: GHG data providers Bloomberg, Clarity AI, ISS, LSEG (consisting of the heritage Refinitiv franchise, FTSE Russell, and others), Morningstar (Morningstar Sustainalytics), MSCI, and S&P Global (S&P Global Trucost Environmental Dataset); FactSet for revenues; and index providers MSCI and SPDJI. No contributors necessarily agree or disagree with the comments or conclusions in this report. Meketa did not audit the data provided. This report does not recommend any metrics, methodology or data provider.

Introduction

The goal of this report is to evaluate the consistency of available corporate Greenhouse Gas ("GHG") emissions data by comparing seven leading data providers' corporate Scope 1, 2, and 3 GHG emission results.

We undertook this research because a growing number of investors are seeking reliable climate data to consider climate risks and opportunities in company valuations and portfolio construction and to potentially help make investment decisions. With increasing investor demand and greater use of climate data in corporate investment securities such as green bonds, the need for harmonized, decision-useful climate data becomes more important to investors and financial markets. We focus on data providers that provide climate data across companies and markets. Data providers collect and review company reported climate data and estimate emissions from companies that do not report or may under report emissions.

Corporate activity is responsible for a significant portion of GHG emissions. Voluntary climate data reporting is increasing in corporate public and private markets. Globally, the number of companies that voluntarily disclosed climate data to the CDP (Carbon Disclosure Project) grew 102-fold from 2002 (228 companies) to 2023 (23,202 companies).[4] Investor interest, climate-related securities such as green bonds, and increasing regulatory climate disclosure requirements may spur more corporations to report climate information and support broader availability of reliable climate data.

Our methodology

We compare corporate GHG emission measurements among seven data providers: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.[5]

We analyze the provider's data for two widely used equity indexes: the U.S. large cap S&P 500 index (505 securities), and the MSCI ACWI which covers large and mid-cap companies (2,964 securities). The two indexes overlapped. The MSCI ACWI included 472 securities that are in the S&P 500. Those 472 securities accounted for 96% of the S&P 500 market share and 57% of the MSCI ACWI market share. We used 2021 rather than 2022 data to help with greater comparability among providers based on when we collected the data (fall 2023).

Our analytic tools

To help compare results across providers, we used comparisons at the total index level, primarily focusing on correlations to compare securities level consistency, along with a ranking of the top 15 highest emitters. For each provider we also analyzed correlations between emissions and revenues.

For each data provider, company reported data is defined as emissions data the provider used that was completely from company reported information. Some providers review company reported data and then partially estimate the emissions for companies that they judge may have underreported or incorrectly reported emissions.[6] For this report, data provider estimated emissions include companies where the data provider partially or fully estimated emissions.

Limits and caveats to our methodology

The findings in this report are limited by several factors. First, we include seven data providers. Results would differ if additional providers were included. Second, the comparative analysis in this report is limited to the constituents of a large cap (S&P 500) and large-mid cap (MSCI ACWI) equity index. Coverage by providers for broader sets of listed securities and for private market securities would likely

include a wider variation in the number of companies covered,[7] and a smaller share of company reported emissions in the total portfolio. Third, this report compares outcomes from different providers. The report does not analyze in depth differences in provider methodologies.[8] Finally, this analysis is limited to data for calendar year 2021 in a rapidly evolving landscape. We used 2021 calendar year data to help improve consistency across providers because we found most company-reported GHG emissions data had at least a one-year lag, and some companies release revised emission data even later. As companies improve their reporting, more companies may restate prior data to improve the comparability of their data across years.

There are several noteworthy caveats to the methodology we used to compare data providers. First, correlations can illustrate general differences, but correlation analysis is highly sensitive to outliers - extreme values that deviate from the rest of the data. If a single index constituent is an extreme outlier for a data provider, correlations with other providers can drop dramatically. Among the correlations analyzed in this report, we found outliers that significantly weakened overall correlations. We provide examples of extreme outliers for reported Scope 1, estimated Scope 2, and reported Scope 3 emissions in Appendix IV. Second, our comparison of data provider's Top 15 emitters in each index are illustrative of similarities among providers but represent just a small sample of rankings. We do not analyze the rankings of all constituents across providers for the full set of S&P 500 and MSCI ACWI constituents.

Background

GHG definitions

The standard guideline for most corporate GHG emissions reporting is the Greenhouse Gas Protocol Corporate Standard, first published in 2001. The Greenhouse Gas Protocol provides accounting and reporting standards.[9] The Corporate Standard defines three scopes of emissions, as shown below.

	Scope 1	Scope 2	Scope 3
What they are	Direct GHG emissions from sources owned or controlled by a company.	Indirect GHG emissions generated by the electricity, steam, heating, and cooling purchased and consumed by a company.	A company's indirect emissions from upstream (purchased goods & services) and downstream (customer uses)
How they are emitted	Company-owned and operated facilities, vehicles, machinery (four direct categories).	Purchased power (one indirect category).	Suppliers, Leased Assets & Transport, Investments, Customer Uses, & End of Life (15 indirect categories)

FIGURE 2
Corporate Level GHG Protocol Reporting Scopes

Source: Greenhouse Gas Protocols as of February 2024.

Data provider calculations of corporate GHG emissions

Calculating GHG emissions is not a trivial exercise. Data providers seek to provide a broad universe of emissions data. To build the universe, they incorporate company reported emissions and estimate emissions for companies that may under report or do not report emissions. For each scope, companies have options under the GHG Protocol on how to calculate their emissions.[10]

Company reported GHG emissions data continues to grow and improve. Globally, the number of companies that voluntarily disclosed GHG emissions to the CDP grew 82-fold between 2002 (228 companies) and 2022 (18,760 companies). Companies that report emissions may improve the reliability of their emissions data by, for example, including all business lines in their reporting. A focus on the most material Scope 3 categories for a company's products and services could help improve company reported emissions, as can using company-specific measures of their emissions instead of industry averages.

The data providers in this review each produce data on Scope 1, 2 and 3 corporate emissions. Data provider methodologies for calculating corporate GHG emissions vary across multiple dimensions. They vary in the breadth of coverage of companies that report data. They differ in their analysis of the quality and completeness of company-reported data, and the determination to partially estimate GHG emissions for companies the provider finds are materially misreporting emissions (under-estimating or over-estimating). Providers differ in the level of sub-industry detail used in developing estimation models and how emissions are handled for conglomerates that cross multiple sub-industries. Providers use different variables to develop company estimates from industry or sub-industry emissions. Provider estimates vary in whether they employ primarily location-based or market-based approaches to calculating Scope 2 and Scope 3 upstream emissions.[11] Provider models vary in the types of estimation tools they use, including for example, input-output models, regression analyses, and machine learning. Provider results for a given year may also differ based simply on different rules for placing companies with a non-December fiscal year end in a calendar year.[12]

Data provider corporate GHG emissions data continues to improve as better inputs become available and estimation models evolve. As more companies report emissions, data providers have more data to assess and estimate emissions. Reporting by more companies for even Scope 1 and Scope 2 emissions may significantly improve overall data, including Scope 3 upstream emissions data. Voluntary reporting standards are becoming more harmonized, making corporate emissions data easier to compare.[13] Climate regulations are coming into force to require disclosure of GHG emissions. Disclosure requirements are expected to increase the number of companies that report quality GHG emissions data.[14] More accurate and less expensive ways to estimate some emissions are improving

emissions data. For example, the March 2024 launch of MethaneSAT offers global high precision satellite data that measures oil and gas methane emissions.[15]

In addition to access to better input data, data providers continue to develop approaches to better estimate missing and underreported corporate emissions data. For example, FTSE Russell recently outlined Scope 3 estimation challenges, different options for modeling, and their approach to better estimation that minimizes their reliance on generalized models that use industry emissions estimates modified by company revenues.[16] Some data providers employ machine learning to improve their estimates. For example, Bloomberg describes how they incorporate machine learning, why they produce a full distribution of estimated emissions rather than a single estimate and discuss additional difficulties in estimating Scope 3 emissions compared to Scope 1 and 2.[17] To increase GHG emissions data reliability and comparability across companies, the asset manager GMO uses an alternative approach to estimating direct (Scope 1) and indirect emissions (Scope 2 and Scope 3) using a bottom up global supply chain model and using consumer data to estimate household downstream emissions.[18]

Comparisons among data providers: percent of companies with reported emissions

As shown below, every data provider included in this report had a higher percentage of companies that reported Scope 1 and 2 emissions than reported Scope 3 reported emissions. In addition, the percentage of companies reporting emissions was higher for the large cap S&P 500 than for the broader MSCI ACWI that covers large and mid-cap stocks. Data provider's inclusion of companies with reported emissions may vary for two main reasons. First, providers may draw from less or more extensive sources to gather reported data. Second, some providers partially estimate results for companies that report emissions if the provider deems company reported emissions are underestimated or over estimated.

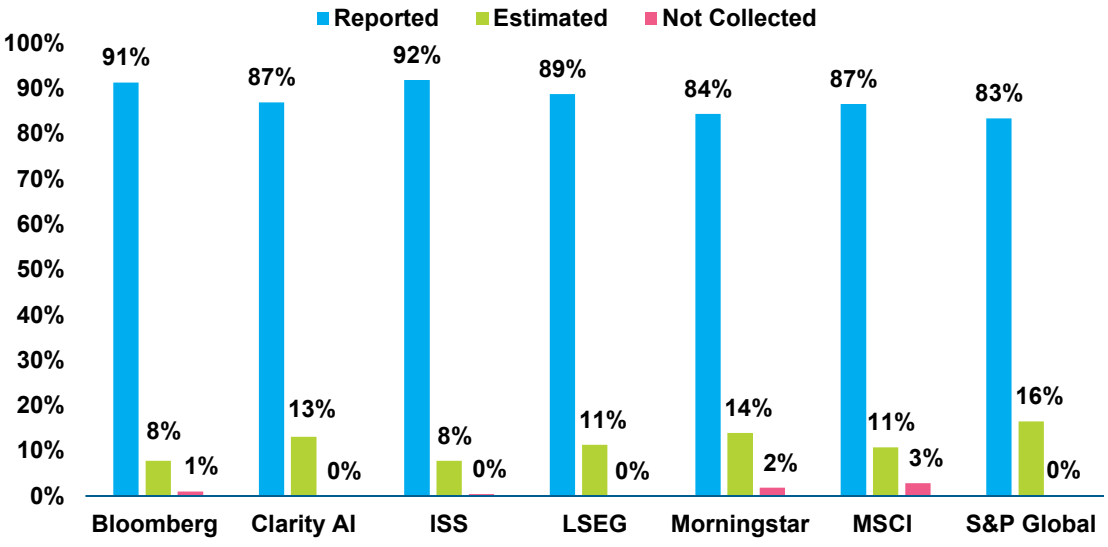

FIGURE 3
S&P 500 Scope 1 + 2 Emissions: Number of Companies that Reported Data

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

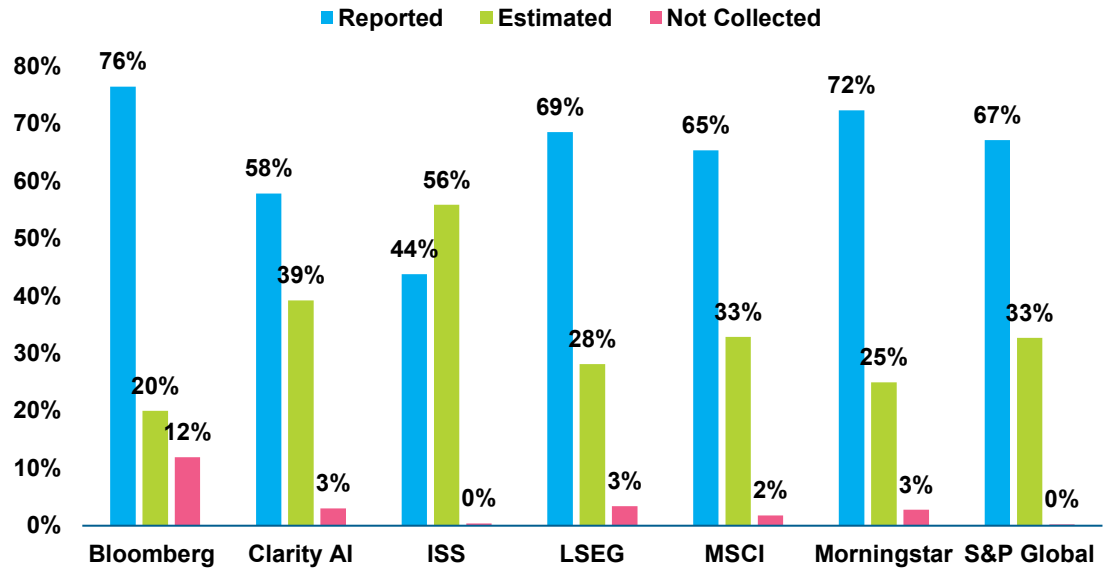

FIGURE 4

S&P 500 Scope 3 Emissions: Number of Companies that Reported Data

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

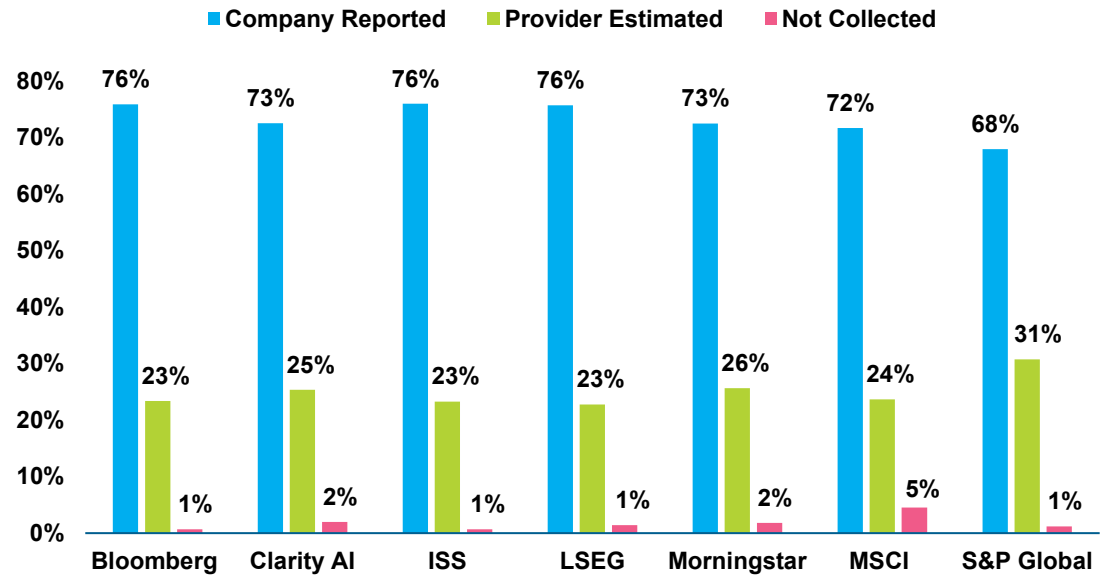

FIGURE 5

MSCI ACWI Scope 1 + 2 Emissions: Number of Companies that Reported Data

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

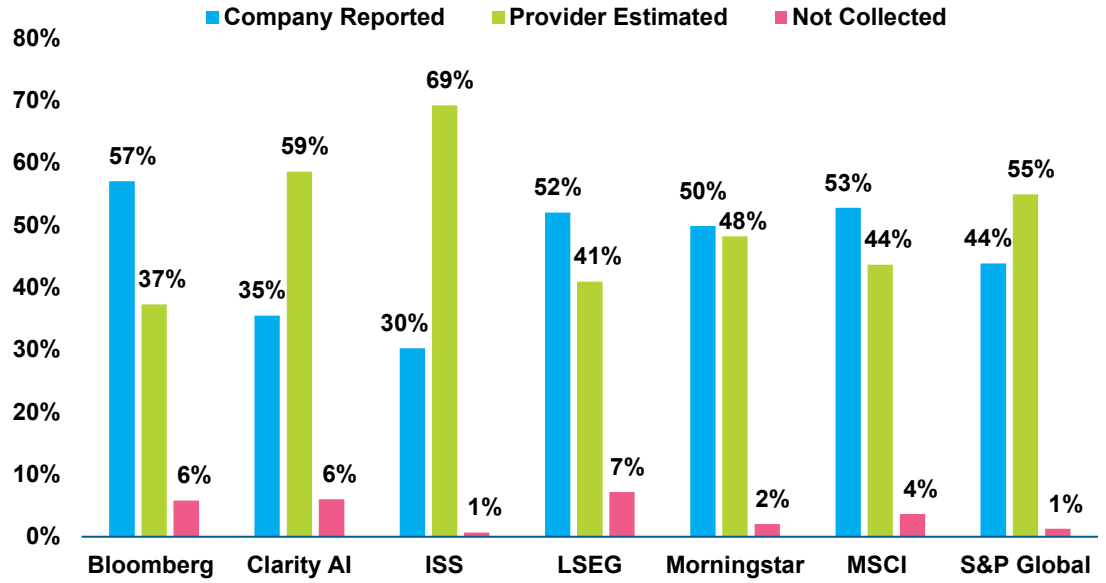

FIGURE 6

MSCI ACWI Scope 3 Emissions: Number of Companies that Reported Data

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

Because larger companies tend to report more complete emissions data, data providers with lower coverage of number of companies with reported data were closer to other providers in coverage based on market share of each index. For both the S&P 500 and the MSCI ACWI, there were more large companies that reported Scope 1 + 2 and Scope 3 data than relatively smaller companies.[19]

	MSCI ACWI		S&P 500	
Universe	Top 100 securities by weight in index	Bottom 100 securities by weight in index	Top 25 securities by weight in index	Bottom 25 securities by weight in index
Universe Market Share	**44%**	**0%**	**38%**	**0%**
Reported Scope 1 + 2				
Number of Companies	96	22	24	21
Market Share of Companies	43%	0%	37%	0%
Reported Scope 3				
Number of Companies	91	4	24	16
Market Share of Companies	41%	0%	37%	0%

FIGURE 7
Emissions Reporting for Top & Bottom Securities by Market Share for MSCI ACWI and S&P 500, 2021

Source: Bloomberg.

As shown in the example, for the S&P 500, 24 of the top 25 companies by weight in the index reported Scope 1 + 2 and Scope 3 data. These 24 companies (5% of companies) accounted for 37% market share of the S&P 500 index. As a large cap index, many companies among the smallest 25 by market share for the S&P 500 (21 companies) reported Scope 1 + 2 and 16 companies reported Scope 3 data. These companies respectively accounted for market shares that rounded to 0% and 0% of the S&P 500 index, respectively.

For the MSCI ACWI we looked at the top 100 and bottom 100 companies by market share of the index. Among the top 100 companies, 96 reported Scope 1 + 2 emissions, and 91 companies reported Scope 3 emissions. These companies respectively accounted for 43% and 41% market share of the MSCI ACWI. In contrast, among the bottom 100 companies by market share weight in the index, 22 companies reported Scope 1 + 2 emissions and four companies reported Scope 3 emissions. These companies respectively accounted for market shares that rounded to 0% and 0% of the MSCI ACWI, respectively.

Comparisons among data providers: Total Emissions and Shares of Scope 1, 2, and 3 emissions

In the figures below, we show the total Scope 1, 2 and 3 emissions for each provider for the full set of securities that each provider has either reported or estimated. Among the seven data providers the magnitude of total emissions varied slightly. The providers recorded roughly similar shares of Scope 1, 2 and 3 emissions within total emissions. The share of Scope 3 emissions accounted for over 80% of emissions for each provider for both the S&P 500 and the MSCI ACWI. For the S&P 500, Scope 3 emissions were 88% to 90% of total emissions for all providers. For the MSCI ACWI, the Scope 3 emission shares ranged from 83% to 85% of total emissions.[20] Scope 1 emissions accounted for 9% to 10% of the S&P 500 and 13% to 15% of MSCI ACWI emissions. Scope 2 accounted for 1% to 2% of S&P 500 emissions and 2% to 3% of MSCI ACWI emissions.

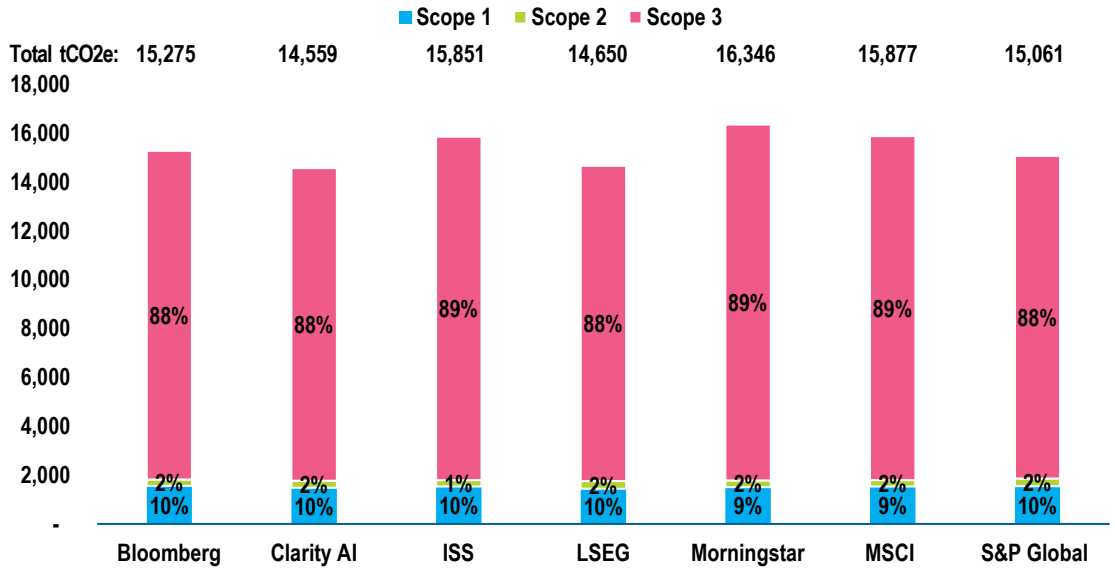

FIGURE 8
S&P 500 Total Emissions (tCO2e) 2021

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

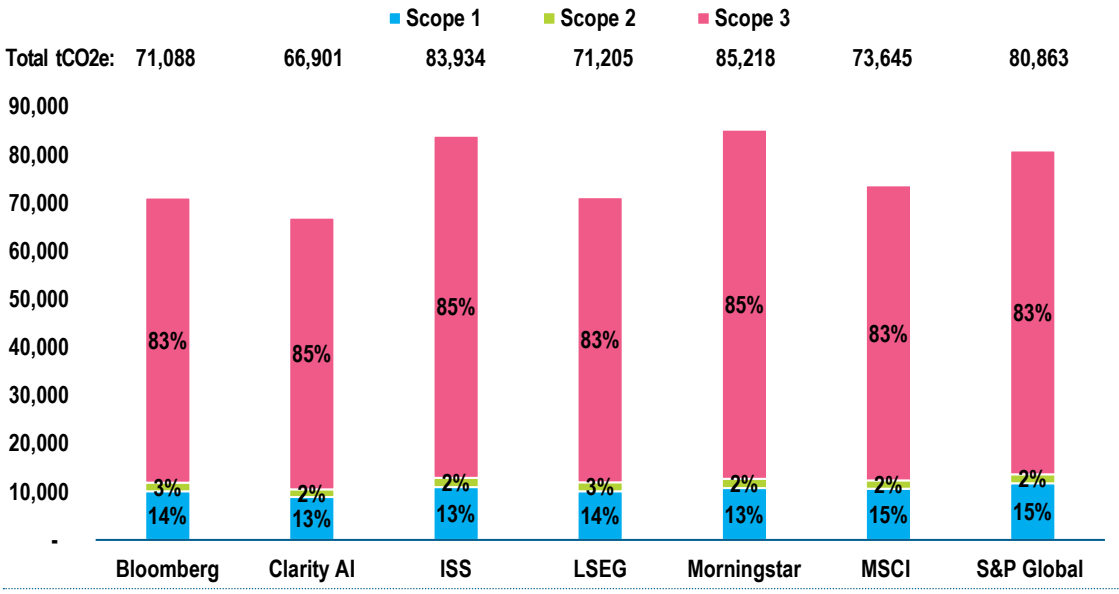

FIGURE 9
MSCI ACWI Total Emissions (tCO2e) 2021

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

The figure below shows total Scope 1, 2, and 3 combined reported and estimated emissions for each data provider compared to the market share covered for the MSCI ACWI.

Provider	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Market Share Coverage	97%	97%	100%	97%	99%	97%	99%
Total Co2e Emissions	71,087	66,901	83,934	71,205	85,218	73,614	80,862

FIGURE 10
Market Share Coverage of MSCI ACWI and Total CO2 Emissions

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

As shown, the data providers each covered 97% to 100% of the MSCI ACWI market share. Providers with similar shares of collected data seem to correspond to similar total emissions measures. Three providers with 99% or more covered emissions reported between 80 and 85 billion total CO2e. The four providers with 97% coverage reported between 67 and 73 billion CO2e.

Correlations among data providers: Scope 1 + 2 emissions

For Scope 1 and 2 emissions, we show correlations for combined (Scope 1 + 2) emissions below. We found very strong correlations that each round to 100% among providers for Scope 1 + 2 emissions on the S&P 500. For the MSCI ACWI, Scope 1 + 2 correlations were above 90% among Bloomberg, ISS, LSEG, Morningstar, MSCI, and S&P Global. Clarity AI showed mixed correlations ranging from 77% to 92% with these providers.

	Bloomberg	*Clarity AI*	*ISS*	*LSEG*	*Morningstar*	*MSCI*	*S&P Global*
Bloomberg	100%						
Clarity AI	100%	100%					
ISS	100%	100%	100%				
LSEG	100%	100%	100%	100%			
Morningstar	100%	100%	100%	100%	100%		
MSCI	100%	100%	100%	100%	100%	100%	
S&P Global	100%	100%	100%	100%	100%	100%	100%

FIGURE 11
S&P 500 Scope 1 + 2 Correlations Among Providers 2021. Number of Observations: 482 securities of 505

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

	Bloomberg	*Clarity AI*	*ISS*	*LSEG*	*Morningstar*	*MSCI*	*S&P Global*
Bloomberg	100%						
Clarity AI	92%	100%					
ISS	95%	81%	100%				
LSEG	97%	85%	97%	100%			
Morningstar	91%	77%	97%	94%	100%		
MSCI	94%	79%	99%	96%	96%	100%	
S&P Global	93%	78%	98%	95%	96%	98%	100%

FIGURE 12
MSCI ACWI Scope 1 +2 Correlations Among Providers 2021. Number of Observations: 2,701 securities of 2,964

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

Because Scope 1 emissions accounted for approximately 4x Scope 2 emissions, we reviewed Scope 1 and Scope 2 emissions separately (see appendices XI), and company reported data separately than provider estimated data. The findings show that there is much higher correlation among providers on reported data than for provider estimated data.

Correlations among data providers: Scope 3 emissions

For Scope 3 emissions, correlations among providers ranged between 72% and 99% for the S&P 500 and between 42% and 90% for the MSCI ACWI.

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	99%	100%					
ISS	86%	85%	100%				
LSEG	99%	97%	82%	100%			
Morningstar	76%	73%	73%	72%	100%		
MSCI	95%	94%	80%	95%	68%	100%	
S&P Global	87%	86%	94%	84%	86%	78%	100%

FIGURE 13
S&P 500 Scope 3 Correlations Among Providers 2021. Number of Observations: 455 securities of 505

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	68%	100%					
ISS	85%	71%	100%				
LSEG	90%	74%	89%	100%			
Morningstar	63%	42%	69%	65%	100%		
MSCI	86%	66%	87%	89%	70%	100%	
S&P Global	82%	70%	89%	87%	55%	79%	100%

FIGURE 14
MSCI ACWI Scope 3 Correlations Among Providers 2021. Number of Observations: 2,467 securities of 2,964

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

As shown in Appendix XII, correlations among providers for both indexes were higher for reported data than for correlations shown above which includes reported estimated data.

Comparison among data providers: top 15 emitting companies

In addition to assessing overall correlations among providers, we looked at which companies were identified as the top 15 emitters by at least a majority (four of the seven providers). We then identified companies that were among the top 15 emitters among all seven data providers.

For the S&P 500 Scope 1 + 2 comparison, twelve companies were common among all seven data providers as top 15 GHG emitters. An additional three companies were among the top 15 for between four to six data providers. For the S&P 500 Scope 3 emissions, the seven providers ranked ten companies in common as top 15 emitters. Four additional companies were common across four to six providers.

S&P 500		MSCI ACWI	
Scope 1 + 2	Scope 3	Scope 1 + 2	Scope 3
American Electric Power Company, Inc.	**Cummins Inc.**	**Anhui Conch Cement Company Limited**	**Cummins Inc.**
Berkshire Hathaway Inc.	**Chevron Corporation**	**China National Building Material Co., Ltd.**	**Saudi Arabian Oil Co.**
Chevron Corporation	**Emerson Electric Co.**	**China Petroleum & Chemical Corporation**	**Siemens Energy AG**
Duke Energy Corporation	**Exxon Mobil Corporation**	**China Shenhua Energy Company Ltd.**	Chevron Corporation
Entergy Corporation	**Ford Motor Company**	**Huadian Power International Corp. Ltd.**	China Petroleum & Chemical Corporation
Exxon Mobil Corporation	**General Motors Company**	**Korea Electric Power Corp.**	China Shenhua Energy Company Limited
NextEra Energy, Inc.	**Marathon Petroleum Corporation**	**NTPC Limited**	Coal India Ltd.
NRG Energy, Inc.	**Phillips 66**	**PetroChina Company Limited**	Emerson Electric Co.
Phillips 66	**The Boeing Company**	**Saudi Electricity Co.**	Exxon Mobil Corporation
The AES Corporation	**Trane Technologies Plc**	ArcelorMittal SA	Gazprom PJSC
The Southern Company	Baker Hughes Company	China Resources Power Holdings Co., Ltd.	Mitsubishi Heavy Industries, Ltd.
Xcel Energy Inc.	Caterpillar, Inc.	Gazprom PJSC	PetroChina Company Limited
Dominion Energy, Inc.	General Electric Company	GD Power Development Co., Ltd.	Rosneft Oil Co.
Linde Plc	The Hartford Financial Services Group, Inc.	Holcim Ltd.	Shell Plc
Marathon Petroleum Corporation		Huaneng Power International, Inc.	The Hartford Financial Services Group, Inc.

FIGURE 15
Top 15 Emitting Companies Common Among Data Providers (Companies in Bold are common across all seven providers)

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

For the MSCI ACWI, there were nine companies in common among the seven data providers as Scope 1 + 2 top 15 emitters. An additional six companies were identified among the top 15 emitters by four to six data providers. For the MSCI ACWI Scope 3, all seven providers had three companies in common among the top 15 emitters. An additional 12 companies were identified among the top 15 for four to six data providers.

In general, these findings indicate that there were significant common results among these seven data providers in identifying the top 15 largest emitters for both Scope 1 + 2 and Scope 3 emissions, for both the S&P 500 and the MSCI ACWI. Please note each provider may have different absolute emissions for specific companies and may not rank companies the same within the top 15 based on Scope 1 + 2 or Scope 3 emissions.

We do not conduct industry breakdowns in this report. However, we note that although thermal coal is one of the highest emitting fossil fuels, there were few companies in the GICS Coal and Consumable Fuels sub-industry among the top 15 highest emitters. This result is primarily due to the nature of the indexes we analyzed. Because we only looked at listed companies in the S&P 500 (large cap) and the MSCI ACWI (large and midcap), exposure to the number of companies identified as GICS sub-industry Coal and Consumable Fuels was limited. In 2021, no coal companies were in the S&P 500 and 12 coal companies were constituents of the MSCI ACWI.[21]

Comparison among data providers: GHG emissions correlation with revenues

Modeling corporate emissions comes with significant challenges. Most data providers we reviewed have developed sophisticated models to estimate GHG emissions. The models can use complex input/output analysis and machine learning.[22] The providers we reviewed rely significantly on industry and/or geographic emissions to model company emissions for companies that partially report, or do not report emissions. The data providers often weight the industry/geographic emissions by company specific factors to estimate company emissions. Using industry-level emissions as a proxy for company emissions can limit how companies distinguish themselves amongst their industry peers on their emissions.[23]

The data providers we reviewed use company revenues to some degree to weight industry emissions and develop company emission estimates. This logical way to estimate company emissions can bias the estimated emissions data to favor companies with lower revenue within the same industry. One analysis of MSCI estimated Scope 3 emissions found that the estimated Scope 3 emissions resulted in favoring lower revenue companies that were also weaker on financial performance metrics compared to peers.[24]

Revenue weights can also incorporate a significant inflation effect, in contrast, for example, to company production weights. We only look at one year of data in this report. However, one analysis found that from 2021 to 2022, emissions estimated using revenues rose materially due in part to price increases.[25]

To look at the significance of data provider biases from relying on revenues to estimate corporate emissions, we compared each data provider's reported emissions correlation with revenues to their estimated emissions correlation with revenues. For Scope 3 emissions, we found a higher correlation with revenues for estimated versus reported emissions across all participating providers.

For the S&P 500, Bloomberg showed the smallest increase in correlation to revenues for estimated Scope 3 emissions compared to reported Scope 3 emissions. For the MSCI ACWI, S&P Global showed the smallest increase in correlations to revenues for estimated Scope 3 emissions compared to reported Scope 3 emissions.

LSEG showed the highest increase from reported to estimated Scope 3 emissions correlation to revenues on the S&P 500. MSCI showed the largest increase in correlation to revenues when moving from Scope 3 reported to estimated emissions for the MSCI ACWI. The results indicate that current data provider Scope 3 estimation models may result in revenue-biased Scope 3 emissions estimates for companies. The significance of these biases varies across providers and depends on methodological differences.

	S&P 500				MSCI ACWI			
	Reported Scope 3		Estimated Scope 3		Reported Scope 3		Estimated Scope 3	
	Correlation with Revenues	# of Securities	Correlation with Revenues	# of Securities	Correlation with Revenues	# of Securities	Correlation with Revenues	# of Securities
Bloomberg	21%	379	27%	89	31%	1,690	61%	1,103
Clarity AI	20%	292	39%	198	27%	1,051	38%	1,733
ISS	24%	221	35%	281	40%	895	53%	2,049
LSEG	26%	346	77%	142	30%	1,540	60%	1212
Morningstar	24%	330	36%	166	34%	1,476	69%	1,423
MSCI	19%	365	42%	126	25%	1,562	68%	1,285
S&P Global	25%	339	36%	165	35%	1,299	45%	1,626

FIGURE 16
Scope 3 Emission Correlations with Revenue

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global. Revenue data from FactSet.

We found no consistent bias among providers in correlations to revenues for Scope 1 or 2 reported versus estimated emissions.

	S&P 500		MSCI ACWI			
	Reported Scope 1		Reported Scope 1		Estimated Scope 1	
	Correlation with Revenues	# of Securities	Correlation with Revenues	# of Securities	Correlation with Revenues	# of Securities
Bloomberg	15%	448	26%	2,205	15%	719
Clarity AI	15%	437	25%	2,110	41%	795
ISS	21%	450	26%	2,170	11%	774
LSEG	15%	455	27%	2,268	18%	654
Morningstar	20%	432	25%	2,171	4%	739
MSCI	16%	443	22%	2,156	21%	673
S&P Global	16%	433	18%	1,993	42%	935

	S&P 500		MSCI ACWI			
	Reported Scope 2		Reported Scope 2		Estimated Scope 2	
	Correlation with Revenues	# of Securities	Correlation with Revenues	# of Securities	Correlation with Revenues	# of Securities
Bloomberg	32%	456	35%	2,240	29%	706
Clarity AI	29%	434	36%	2,116	45%	789
ISS	30%	464	36%	2,253	27%	691
LSEG	41%	449	39%	2,282	57%	640
Morningstar	50%	426	37%	2,175	19%	735
MSCI	50%	437	37%	2,143	42%	686
S&P Global	35%	423	39%	2,036	76%	892

FIGURE 17
Scope 1 and 2 Emission Correlations with Revenue

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global. Revenue data from FactSet.

Conclusions

Based on the current state of available GHG emissions data, as illustrated in this comparison of data from seven leading data providers, we find that Scope 1 and 2 emissions data may fairly reliably be used with consistent results from these providers. Scope 3 emissions represent the vast majority of corporate emissions. They are also the most difficult to estimate and have the least company reported data among these providers. We found a consistent bias among these seven data providers showing that Scope 3 estimated emissions were more highly correlated with revenues than Scope 3 reported emissions.

At this juncture, treating Scope 3 emissions separately from Scopes 1 and 2 emissions may improve investor use of Scope 1, 2 and 3 GHG emissions data. Similarly, metrics that incorporate GHG emissions such as carbon footprint and carbon intensity may be best analyzed separating Scope 1 and 2 emissions intensity from Scope 3 intensity. Additional granularity on Scope 3 upstream and downstream emissions, along with additional climate metrics may further enhance investor understanding of the energy transition risks and opportunities that companies represent.

Appendices

Appendix I: Climate metric definitions

Term	Definition
Greenhouse Gases ("GHGs")	GHGs are gases in the earth's atmosphere that trap heat and have the effect of warming the global climate. They include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PCFs), sulfur hexafluoride (SF6) and nitrogen trifluoride (NF3).
Carbon Footprint	Carbon footprint is the annual amount of greenhouse gas emissions, mainly CO2. This metric is calculated by summing the value of each investment per adjusted Enterprise Value multiplied by emissions ("tCO2e") and then dividing by the portfolio's total market value (per million).
Carbon Efficiency	Carbon efficiency refers to the ecological efficiency related to reducing carbon emissions.
Emissions Intensity	Carbon intensity is expressed as the issuer's total carbon emissions per million USD of revenue as a proxy of the carbon efficiency per unit of output.
Implied Temperature Rise	Implied temperature rise refers to the projected increase in global temperatures resulting from current and future greenhouse gas emissions.
Transition Value at Risk	Transition value at risk (TVaR) indicates the potential financial implications of transitioning to a low-carbon economy.
Carbon Budget	The carbon budget represents the maximum cumulative net global emissions that would limit global warming to a specific level.
Scope 4 Emissions	Scope 4 emissions, also known as avoided emissions, focus on the positive impact achieved by creating environmentally friendly products.
Net Zero Target	Net Zero GHG targets are targets consistent with limited global temperature rise to 1.5 degrees Celsius.
Green Revenue Share	Percentage of revenue/turnover generated by the company that is green/sustainable, as defined by the company.
Energy Efficiency	Energy efficiency is using less energy to generate the same amount of output.
Green Capex	Green Capital Expenditure refers to the capital investment made in sustainable economic activities.
Scope 1 Emissions	Scope 1 emissions are generated directly from a company's business operations.
Scope 2 Emissions	Scope 2 emissions are the indirect emissions generated from purchased energy.
Scope 3 Emissions	Scope 3 emissions are generated by a company's suppliers and customers' use of its products and services.
Location Based	Location based emissions are determined by the average emissions intensity of the local electricity grid, where energy consumption occurs.
Market Based	Market based emissions are determined by the actual energy sources a company has chosen to support through its purchasing decisions.

FIGURE 18
Climate Metric Definitions

Source: Meketa Investment Group, 2024.

Appendix II: The state of voluntary and regulatory emissions disclosure frameworks

Significant strides have been made in voluntary disclosure frameworks to support aggregation and publication of harmonized corporate emissions data.[26] In June 2023, the International Sustainability Standards Board ("ISSB") published its first two finalized International Financial Reporting Standards ("IFRS") Sustainability Disclosure Standards.[27] The standards incorporate prior Sustainability Accounting Standards Board ("SASB") industry industry-specific materiality.[28] Voluntary, market-driven efforts to increase sustainability disclosure for private markets are increasing, particularly in the US. These include the EDCI (ESG Data Convergence Initiative) and the ESG Integrated Data Project ("ESG IDP"),[29] whose template includes the EDCI questions and is designed to be harmonized with leading standards.

Market demand is bolstered by regulatory disclosure requirements that are beginning to come into force around the world.[30] For example, in the EU, the European Commission ("EC") finalized the Corporate Sustainability Reporting Directive ("CSRD") on January 5, 2023. The CSRD climate disclosure requirements include Scopes 1, 2 and 3. The requirements applied for some companies as of January 2024. The requirements start applying to additional companies at various times through 2028.[31] The United Kingdom's ("UK") Streamlined Energy and Carbon Reporting (the SECR comply-or-explain policy,[32] which was finalized and implemented for financial years beginning on or after April 1, 2019, for listed companies, large unlisted companies and large limited liability partnerships requires Scope 1 and 2 GHG emissions reporting; while, Scope 3 is voluntary but strongly recommended.[33] The 2024 U.S. Securities and Exchange Commission ("SEC") climate disclosure rule requires Scope 1 and Scope 2 emissions disclosure for large, listed companies.[34] Legal challenges have been filed from proponents that say it does not go far enough and from those that seek to reduce or overturn the rule. In total, seven legal suits have been filed. These include state attorneys general, two energy companies, oil and industry groups, the Ohio Bureau of Workers' Compensation, and the Sierra Club.[35] Under the California GHG disclosure rule that was signed on October 7, 2023, large companies operating in California would begin reporting Scope 1, 2 and 3 emissions data in 2026 (legal challenges have been filed).[36]

In 2024, the China Securities Regulatory Commission ("CSRC") released draft climate disclosure requirements that would mandate Scope 1 and Scope 2 disclosure for large, listed companies, while Scope 3 GHG emissions reporting would remain voluntary. In June 2021, Tokyo Stock Exchange, Inc. ("TSE") implemented revisions to the Corporate Governance Code that mandated Prime Market-listed companies to report TCFD disclosures and address social matters in a "comply or explain" basis.[37] The recommendation covers Scope 1, 2 and 3 GHG emissions. A final version based on the ISSB standardized climate-related disclosures is scheduled for release by the Sustainability Standards Board of Japan ("SSBJ") no later than April 2025, and reporting is expected to begin in mid-2026. The Reserve Bank of India ("RBI") set requirements for regulated entities (Res) to disclose climate-related risks starting in April 2025.[38] Singapore plans to introduce mandatory climate reporting rules that become effective in 2025.[39] Malaysia launched a consultation on ISSB adoption, proposing to start reporting beginning in December 2025.[40]

Appendix III: Data provider coverage of corporate Scope 1 + 2, and 3 emissions

Below we provide summary information on when each data provider first began offering emissions data and the number of companies each provider covered as of December 2023. S&P Global provided separated upstream and downstream data. Based on the S&P Global data, more than 67% of the issuers in the S&P 500 reported downstream data compared to 17% that reported upstream Scope 3 emissions.

Data Provider	Year Initiated Coverage	Scope 1 + 2	Scope 3
Bloomberg	2006	130,000	120,000
Clarity AI	2017	51,115	47,744
ISS	2012	35,726	35,719
LSEG	2002	30,000	25,000
Morningstar	2017	13,182	12,921
MSCI	2014	115,000	115,000
S&P Global	2002	17,000 public. 3.5 million private	17,700 downstream 3.5 million upstream

FIGURE 19
Emissions Data Reporting: Total Number of Companies (Reported and Estimated; publicly and privately held)

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

Appendix IV: Examples of material changes in correlations due to a single security

	Security Name	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Provider 6	Provider 7
Reported Scope 1	TURKIYE SISE VE CAM FABR	4,714,195	4,714,195	4,714,195	4,714,195	4,714,195	4,714,195	3,019,240,000
	Updated Value	4,714,195	4,714,195	4,714,195	4,714,195	4,714,200	4,714,195	2,542,040
Estimated Scope 2	Berkshire Hathaway Inc.	1,660,886	44,864,652	2,741,258	6,042,027	5,228,320	5,486,964	471,463
Reported Scope 3	Walmart	35,358	245,289,145	245,289,145	245,289,145	37,439	82,657,706	171,269,379
	Corrected Value	242,835,480	245,289,145	245,289,145	245,289,145	242,835,480	82,657,706	171,269,379

FIGURE 20
Examples of reported and estimated single securities that can materially change correlations among providers (Metric tons C02e)

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

Note: For security purposes, the data provider is not listed alphabetically.

Reported Scope 1 example: Türkiye Sise Ve Cam Fabr, a constituent of the MSCI ACWI, involved the data provider inputting incorrect Scope 1 reported data. This resulted in the provider showing very low correlations with other providers. After correcting the Scope 1 reported data for that single security, the provider's correlations with other providers corrected from the 20th percentile to the 90th percentile, similar to correlations among other providers.

Estimated Scope 2 example: Berkshire Hathaway (BRKA, a constituent of the S&P 500) provides an example of wide dispersion for Scope 2 emissions estimates across providers. For this security, the highest provider estimate was 95x the lowest provider estimate.

Reported Scope 3 example: A third example illustrates how the timing of when companies fully report data and when data providers collect and update their data can significantly impact the quality of the data. For Walmart Inc.'s Scope 3 emissions, two data providers researched FY '21 before updated company reports were available. A comprehensive report (CDP) was released after the providers had collected their 2021 data. Walmart was a constituent in the S&P 500 and in the MSCI ACWI.

Appendix V: The GHG Protocol Corporate Standard

The GHG Protocol Corporate Standard was first issued in September 2001. Since its initial publication, the GHG Protocol Corporate Standard has become widely accepted. The Scope 3 Corporate Value Chain GHG Protocol was published in 2011, followed by the Scope 2 Corporate Protocol in 2015 which allows companies to credibly measure and report emissions from purchased or acquired electricity, steam, heat, and cooling. Currently new final standards and guidance based on 2023 survey responses, including possible standards for Scope 4 (avoided emissions) are expected in 2025.[41] The GHG Protocol provides the most widely used foundation for corporate reporting and for data providers that estimate GHG emissions for companies that either partially report or do not report.

The standard covers the accounting and reporting of seven greenhouse gases covered by the Kyoto Protocol – carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PCFs), sulfur hexafluoride (SF6) and nitrogen trifluoride (NF3).

Options for company calculations of emissions

For each scope, companies have options under the GHG Protocol for how to calculate their emissions. The options make it easier for companies to calculate emissions, but more difficult to compare emissions between companies. Reported emissions by companies typically include some estimation in calculations of each scope that a company reports. Scope 1 and 2 are easier to estimate than Scope 3 emissions. Scope 1 (direct emissions) includes four categories of emissions (stationary combustion, mobile combustion, fugitive emissions, and process emissions). Scope 2 emissions includes one category (indirect emissions from purchased power). Scope 3 encompasses indirect emissions from suppliers and emissions from customer use of products and services after they are sold. Scope 3 includes 15 categories of emissions in the GHG Protocol.[42]

Scope 3 emissions are easy to understand as a concept. They are not as widely reported by companies because they can be complex to measure. Some companies have an additional incentive to voluntarily report Scope 3 emissions because they are changing their suppliers and/or product suite to reduce their Scope 3 emissions, and in some cases issuing green bonds linked to their development of low carbon products.[43]

Companies that report emissions, particularly Scope 3 emissions, may also update and improve their estimation methodology over time, resulting in inconsistent company emissions data over time.[44] Differing methods for estimating emissions may result in varying emissions results. Two examples of options for calculating emissions in the GHG Protocol Corporate Standard include:

- **Option to use industry or regional averages rather than company specific estimates.** Due to the difficulty in measuring emissions, the GHG Protocol Corporate Standard allows companies to use industry and regional averages to report emissions, or measure the specific emissions produced by their processes, actual suppliers, distributors, and customers. Industry and regional averages make it far more feasible to calculate emissions, particularly for Scope 3. However, industry averages often cannot accurately distinguish between companies in the same industry with better or worse than average emissions. The differences between using industry averages compared to company-specific measures may be compounded for Scope 3 and the difficulty in measuring specific emissions is significantly more challenging.

  As the energy transition progresses, the range of emissions for the same levels of production may widen among companies in some higher emitting sectors based on different methods of production. A few examples include:[45] a steel company that recycles scrap steel in energy-efficient furnaces or that uses the HIsarna method of ironmaking will have far lower GHG content per ton than a competitor that processes pig iron and metallurgical coal through high-polluting blast furnaces. A consumer-goods company producing paper products from recycled fiber typically emits lower GHGs than one using fiber processed from virgin forests. Concrete companies that replace fly ash, produced from burning coal, with recycled glass will typically have lower emissions per ton than their competitors. Cattle farms that use low-methane feed and fertilizers, or that capture and recycle methane produced from animal waste and agricultural runoff, can produce lower-carbon beef products.

- **Option to use market-based and/or location-based estimates to calculate Scope 2 and upstream Scope 3.** The GHG Corporate Standard allows companies to report Scope 2 and upstream Scope 3 estimates using either market-based or location-based reporting of emissions. Market-based emissions focus on the individual company and its contract agreements in the market to purchase energy. Location-based measures are calculated using solely the average emission intensity of the local grid where a company (Scope 2), or its suppliers (Scope 3) source their power. Some companies report both market-based and location-based.

Appendix VI: Data providers use of location-based and market-based data

Reported emissions used by data providers may vary because companies have options under the GHG Protocol in how to calculate their emissions. Data providers may prefer market-based as their primary data estimation technique, or location-based, as shown below. We note that providers often evolve their approaches. For example, in 2023, S&P Global adopted market-based emissions as their primary Scope 2 data, replacing their previous rule to use location-based data as primary.

Data Provider	Scope 2 Prioritize Location-based or Market-based Data
Bloomberg	Market-based primary Location-based secondary
Clarity AI	Market-based primary Location-based secondary
ISS	Market-based primary
Location-based secondary	Carbon intensity is expressed as the issuer's total carbon emissions per million USD of revenue as a proxy of the carbon efficiency per unit of output.
LSEG	Location-based primary Market-based secondary
Morningstar	Location-based primary Market-based secondary
MSCI	Location-based primary Market-based secondary
S&P Global	Market-based secondary Location-based primary

FIGURE 21
Location and Market-Based Data

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

Appendix VII: Provider rules on calendar year end aggregation across non-December company FYEs

Providers placed companies with non-December fiscal year ends ("FYE") in calendar years differently.

Data Provider	Fiscal Year End cutoff to include in prior calendar year
Bloomberg	Jan 15
Clarity AI	Feb 10 (US) Jan 15 (non-US)
ISS	June 30
LSEG	Feb 10 (US) Jan 15 (non-US)
Morningstar	Dec 31
MSCI	May 31
S&P Global	Jan 15

FIGURE 22
Fiscal Year-End Rules

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

Different FYE rules had minimal impact on provider correlations because few companies had a FYE between February and May/June when different providers may have different FYE cut off dates, while all providers included firms with a FYE after June 30 in the same calendar year.

	S&P 500			MSCI ACWI		
FY-End	Number of Companies	% of Companies	% of Mkt. Share	Number of Companies	% of Companies	% of Mkt. Share
Jan	29	6%	8%	38	1%	4%
Feb	2	0%	0%	15	1%	0%
Mar	8	2%	0%	359	12%	8%
Apr	8	2%	1%	9	0%	0%
May	9	2%	1%	11	0%	1%
Jun	19	4%	9%	106	4%	7%
Jul	7	1%	1%	11	0%	1%
Aug	6	1%	2%	20	1%	1%
Sep	20	4%	10%	56	2%	7%
Oct	16	3%	3%	21	1%	2%
Nov	4	1%	0%	8	0%	1%
Dec	377	75%	64%	2,203	74%	65%
FYE NA				107	4%	3%
Total	**505**	**100%**	**100%**	**2,964**	**100%**	**100%**

FIGURE 23
Fiscal Year-End For companies in S&P 500 and MSCI ACWI Indices

Sources: SPDJI Indexes and MSCI.

Appendix VIII: S&P 500 reported, estimated, and uncollected GHG emissions by each data provider

S&P 500	Bloomberg	Clarity AI	ISS	LSEG	Morning-star	MSCI	S&P Global
Scope 1							
Reported: % of market share	95%	94%	96%	96%	94%	94%	93%
Reported: % of companies	89%	87%	89%	90%	86%	88%	86%
Reported: number of companies	448	437	450	455	432	443	433
Estimated: % of market share	3%	6%	3%	4%	5%	5%	7%
Estimated: % of companies	7%	13%	10%	10%	13%	10%	14%
Uncollected: % of market share	2%	0%	0%	0%	1%	1%	0%
Uncollected: % of companies	**5%**	**0%**	**0%**	**0%**	**2%**	**3%**	**0%**
Scope 2							
Reported: % of market share	95%	94%	97%	95%	92%	94%	92%
Reported: % of companies	89%	86%	92%	89%	84%	87%	84%
Reported: number of companies	456	434	464	449	426	437	423
Estimated: % of market share	3%	6%	2%	5%	7%	5%	8%
Estimated: % of companies	7%	14%	8%	11%	14%	11%	16%
Uncollected: % of market share	2%	0%	0%	0%	1%	1%	0%
Uncollected: % of companies	5%	0%	0%	0%	2%	3%	0%
Scope 3							
Reported: % of market share	87%	68%	66%	79%	80%	84%	77%
Reported: % of companies	75%	58%	44%	69%	65%	72%	67%
Reported: number of companies	379	292	221	346	330	365	339
Estimated: % of market share	9%	30%	33%	18%	19%	15%	23%
Estimated: % of companies	18%	39%	55%	28%	33%	25%	32%
Uncollected: % of market share	4%	2%	0%	3%	1%	1%	0%
Uncollected: % of companies	7%	3%	0%	3%	2%	3%	0%

FIGURE 24
Percent reported, estimated and uncollected data across providers

Sources: Bloomberg, Clarify AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

Appendix IX: MSCI ACWI: reported, estimated and uncollected GHG emissions by each data provider

MSCI ACWI	Bloomberg	Clarity AI	ISS	LSEG	Morning-star	MSCI	S&P Global
Scope 1							
Reported: % of market share	92%	90%	93%	93%	90%	90%	88%
Reported: % of companies	74%	71%	73%	77%	73%	73%	67%
Reported: number of companies	2,205	2,110	2,170	2,268	2,156	2,171	1,993
Estimated: % of market share	7%	10%	7%	7%	7%	9%	11%
Estimated: % of companies	24%	27%	26%	22%	23%	25%	32%
Uncollected: % of market share	1%	0%	0%	0%	3%	1%	0%
Uncollected: % of companies	**1%**	**2%**	**1%**	**1%**	**5%**	**2%**	**1%**
Scope 2							
Reported: % of market share	93%	90%	95%	92%	89%	90%	88%
Reported: % of companies	76%	71%	76%	77%	72%	73%	69%
Reported: number of companies	2,240	2,116	2,253	2,282	2,143	2,175	2,036
Estimated: % of market share	7%	9%	5%	7%	7%	9%	11%
Estimated: % of companies	24%	27%	23%	22%	23%	25%	30%
Uncollected: % of market share	0%	0%	0%	1%	3%	1%	0%
Uncollected: % of companies	1%	2%	1%	1%	5%	2%	1%
Scope 3							
Reported: % of market share	84%	62%	60%	77%	80%	76%	72%
Reported: % of companies	57%	35%	30%	52%	53%	50%	44%
Reported: number of companies	1,690	1,051	895	1,540	1,562	1,476	1,299
Estimated: % of market share	13%	35%	40%	20%	17%	22%	28%
Estimated: % of companies	37%	59%	69%	41%	44%	48%	55%
Uncollected: % of market share	2%	2%	0%	4%	3%	1%	0%
Uncollected: % of companies	6%	6%	1%	7%	4%	2%	1%

FIGURE 25
Percent Reported, Estimated and Uncollected Data Across Providers

Sources: Bloomberg, Clarify AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

Appendix X: S&P 500 Scope 1 and 2 correlations among providers for reported and estimated data

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	100%	100%					
ISS	100%	100%	100%				
LSEG	100%	100%	100%	100%			
Morningstar	100%	100%	100%	100%	100%		
MSCI	100%	100%	100%	100%	100%	100%	
S&P Global	100%	100%	100%	100%	100%	100%	100%

FIGURE 26
S&P 500 (Reported and Estimated) Scope 1 Correlations Among Providers 2021. Number of Observations: 480 securities of 505

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	100%	100%					
ISS	100%	100%	100%				
LSEG	100%	100%	100%	100%			
Morningstar	100%	100%	100%	100%	100%		
MSCI	100%	100%	100%	100%	100%	100%	
S&P Global	100%	100%	100%	100%	100%	100%	100%

FIGURE 27
S&P 500 Reported Scope 1 Correlations Among Providers 2021. Number of Observations: 355 securities of 505

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

Please note that the correlations all round to 100% for the S&P500 due to the very high number of companies that report Scope 1 emissions and the relatively similar estimates among providers for any Scope 1 emissions that any providers may deem as partially reported.

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	98%	100%					
ISS	98%	99%	100%				
LSEG	86%	86%	86%	100%			
Morningstar	87%	87%	87%	95%	100%		
MSCI	94%	95%	95%	89%	88%	100%	
S&P Global	89%	87%	88%	90%	90%	93%	100%

FIGURE 28
S&P 500 (Reported and Estimated) Scope 2 Correlations Among Providers 2021. Number of Observations: 470 securities of 505

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	99%	100%					
ISS	99%	100%	100%				
LSEG	84%	84%	85%	100%			
Morningstar	85%	86%	86%	96%	100%		
MSCI	95%	96%	96%	87%	89%	100%	
S&P Global	90%	91%	91%	91%	94%	94%	100%

FIGURE 29
S&P 500 Reported Scope 2 Correlations Among Providers 2021. Number of Observations: 338 securities of 505

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

Appendix XI: Correlations among providers for MSCI ACWI Scope 1 and 2 reported and estimated data

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	91%	100%					
ISS	96%	81%	100%				
LSEG	94%	79%	95%	100%			
Morningstar	90%	75%	97%	92%	100%		
MSCI	93%	76%	99%	94%	96%	100%	
S&P Global	92%	76%	97%	94%	96%	98%	100%

FIGURE 30
MSCI ACWI (Reported and Estimated) Scope 1 Correlations Among Providers 2021. Number of Observations: 2,668 securities of 2,964

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	99%	100%					
ISS	100%	99%	100%				
LSEG	98%	98%	98%	100%			
Morningstar	100%	99%	100%	99%	100%		
MSCI	100%	99%	100%	98%	100%	100%	
S&P Global	100%	99%	100%	98%	100%	100%	100%

FIGURE 31
MSCI ACWI Reported Scope 1 Correlations Among Providers 2021. Number of Observations: 1,468 securities of 2,964

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	71%	100%					
ISS	75%	50%	100%				
LSEG	52%	64%	27%	100%			
Morningstar	46%	60%	20%	88%	100%		
MSCI	85%	52%	76%	33%	28%	100%	
S&P Global	88%	61%	71%	39%	24%	86%	100%

FIGURE 32
MSCI ACWI Estimated Scope 1 Correlations Among Providers 2021. Number of Observations: 390 securities of 2,964

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	97%	100%					
ISS	90%	91%	100%				
LSEG	95%	95%	90%	100%			
Morningstar	89%	89%	84%	91%	100%		
MSCI	97%	97%	91%	97%	90%	100%	
S&P Global	95%	95%	89%	97%	90%	97%	100%

FIGURE 33
MSCI ACWI (Reported and Estimated) Scope 2 Correlations Among Providers 2021. Number of Observations: 2,652 securities of 2,964

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	98%	100%					
ISS	98%	99%	100%				
LSEG	97%	98%	99%	100%			
Morningstar	97%	98%	99%	100%	100%		
MSCI	98%	99%	99%	99%	99%	100%	
S&P Global	97%	98%	99%	99%	99%	99%	100%

FIGURE 34

MSCI ACWI Reported Scope 2 Correlations Among Providers 2021. Number of Observations: 1,470 securities of 2,964

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	81%	100%					
ISS	39%	49%	100%				
LSEG	75%	78%	46%	100%			
Morningstar	83%	84%	45%	81%	100%		
MSCI	77%	83%	39%	83%	84%	100%	
S&P Global	49%	69%	35%	58%	54%	58%	100%

FIGURE 35

MSCI ACWI Estimated Scope 2 Correlations Among Providers 2021. Number of Observations: 395 securities of 2,964

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

Appendix XIII: Correlations among providers for Scope 3 reported emissions

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	99%	100%					
ISS	86%	85%	100%				
LSEG	99%	97%	82%	100%			
Morningstar	76%	73%	73%	72%	100%		
MSCI	95%	94%	80%	95%	68%	100%	
S&P Global	87%	86%	94%	83%	86%	78%	100%

FIGURE 36
S&P 500 (Reported and Estimated) Scope 3 Correlations Among Providers 2021. Number of Observations: 449 securities of 505

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	99%	100%					
ISS	100%	98%	100%				
LSEG	99%	98%	98%	100%			
Morningstar	99%	98%	100%	98%	100%		
MSCI	99%	98%	100%	98%	100%	100%	
S&P Global	99%	99%	97%	99%	97%	97%	100%

FIGURE 37
S&P 500 Reported Scope 3 Correlations Among Providers 2021. Number of Observations: 146 securities of 505

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	95%	100%					
ISS	99%	96%	100%				
LSEG	98%	97%	97%	100%			
Morningstar	96%	97%	96%	97%	100%		
MSCI	99%	95%	99%	96%	97%	100%	
S&P Global	85%	82%	85%	84%	82%	84%	100%

FIGURE 38
MSCI ACWI Reported Scope 3 Correlations Among Providers 2021. Number of Observations: 465 of 2,964

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

	Bloomberg	Clarity AI	ISS	LSEG	Morningstar	MSCI	S&P Global
Bloomberg	100%						
Clarity AI	85%	100%					
ISS	93%	92%	100%				
LSEG	92%	92%	96%	100%			
Morningstar	70%	46%	69%	69%	100%		
MSCI	90%	85%	96%	94%	78%	100%	
S&P Global	88%	94%	96%	92%	53%	90%	100%

FIGURE 39
MSCI ACWI Estimated Scope 3 Correlations Among Providers 20211. Number of Observations: 784 of 2,964

Sources: Bloomberg, Clarity AI, ISS, LSEG, Morningstar, MSCI, and S&P Global.

[1] Voluntary and regulatory disclosure requirements continue to evolve. Multiple jurisdictions are beginning to require corporate emissions disclosure (ESG Book, April 2024: ESG Policy Digest. In the US a recent Securities and Exchange rule requires large and mid-size publicly listed companies to report Scope 1 and 2 emissions if material, and California requires large publicly held and privately held companies doing business in California to disclose Scope 1, 2 and 3 emissions. Both the SEC and California rule face litigation.

[2] See Appendix I for climate metric definitions.

[3] See Appendix II for a high-level summary of climate disclosure regulations around the world.

[4] Source: CDP, 2024: CDP 2023 disclosure data factsheet.

[5] See Appendix III for year each data provider began offering GHG emissions data and the number of companies covered today.

[6] Some data providers, for example MSCI, offer reported data when available from companies but use their own estimates across all companies for their own analyses and reports. This approach could potentially provide better consistency in emissions data across companies but may reduce accuracy for those companies that report reliable data. For this report, we used reported emissions for companies where the provider makes company reported data available to clients, even if the provider only uses estimated data for their analyses.

[7] See Appendix III for number of companies covered among the data providers in this review.

[8] For a recent review of climate tools: UN Environment Programme Climate Initiative: April 2024, "2024 Climate Risk Landscape Report."

[9] Source: Greenhouse Gas Protocols as of February 2024.

[10] See Appendix V.

[11] See Appendix VI.

[12] See Appendix VII for provider rules on calendar year placement of companies with a non-December FYE, and the FYE monthly dispersion of S&P 500 and MSCI ACWI firms.

[13] See Appendix II for a high-level summary of climate disclosure regulations around the world.

[14] See Appendix II for a high-level summary of climate disclosure regulations around the world.

[15] Source: MethaneSAT.org

[16] FTSE Russell, January 2024, "Scope for improvement: Solving the Scope 3 conundrum.

[17] Source: Bloomberg, 2022: "Bloomberg's Greenhouse Gas Emissions Estimates Model".

[18] GMO, 2023, "Estimating Value Chain Emissions for Portfolio Construction" and August 2023, "Estimating Value Chain Emissions for Asset Managers".

[19] Source: Bloomberg.

[20] See Appendix VIII (S&P 500) and IX (MSCI ACWI) for tables showing the percentages of reported, estimated and uncollected data for each provider. See Appendix X for tables correlations among providers on the total emissions for Scope 1 separately from Scope 2 using only securities that all seven data providers had either reported or estimated data (no uncollected data from any provider).

[21] In 2021, no coal companies were large enough by market share to be constituents of the S&P 500. The largest US coal mining company today, Peabody Energy Corp, was dropped from the S&P 500 Index September 22, 2014. Peabody was added to the S&P SmallCap 600 in January 2024. Two companies in the GICS sub-industry Coal and Consumable Fuels were found among the top 15 highest emitters in the MSCI ACWI for at least four data providers: Coal India (Scope 3), and China Shenhua Energy Company Limited (Scopes 1 + 2 and 3).

[22] Sources: For example, FTSE/Russell, January 2024 "Scope for Improvement: Solving the Scope 3 conundrum: provides a detailed discussion of the challenges in modeling Scope 3 emissions and the FTSE/Russell approach". Bloomberg,2022, "Bloomberg's Greenhouse Gas Emissions Estimates Model outlines how Bloomberg incorporates machine learning".

[23] Source: GMO, July 2023: Estimating Value Chain Emissions for Portfolio Construction.

[24] Source: Osmosis Investment Management, "The Obstructive Role of Scope 3 Data in Portfolio Construction", November 2022.

[25] Source: S&P Global, Sustainable1, April 2024: Emissions Data: Year on Year Changes, FY2021-FY2022.

[26] Sources: MSCI: "Carbon Footprinting Demystified" May 2024 Clarkin, C. et al. (2020) The rise of standardized ESG disclosure frameworks in the United States, The Harvard Law School Forum on Corporate Governance. Available at: https://corpgov.law.harvard.edu/2020/06/22/the-rise-of-standardized-esg-disclosure-frameworks-in-the-united-states/ (Accessed: 05 April 2024).

[27] Source: Climate Related Disclosures (June 2023) IFRS. Available at: https://www.ifrs.org/projects/completed-projects/2023/climate-related-disclosures/ (Accessed: 25 March 2024).

[28] Source: Your pathway to ISSB (2024) SASB. Available at: https://sasb.ifrs.org/sasb-your-pathway-to-issb/ (Accessed: 25 March 2024.)

[29] Sources: EDCI - https://www.esgdc.org/; ESG IDP - https://www.esgidp.org/

[30] Sources: ESG Book, April 2024: ESG Policy Digest. ESG Policy World Resources Institute, March 7, 2024: What Are Greenhouse Gas Accounting and Corporate Climate Disclosures? 6 Questions, Answered; MSCI: Carbon Footprinting Demystified, May 2024

[31] Source: Triggs, M., Mishkin, S. and Meynier, T. (2023) EU finalizes ESG reporting rules with international impacts, The Harvard Law School Forum on Corporate Governance. Available at: https://corpgov.law.harvard.edu/2023/01/30/eu-finalizes-esg-reporting-rules-with-international-impacts/ (Accessed: 25 March 2024).

[32] Source: Department for Energy Security and Net Zero (2019) Environmental reporting guidelines: Including streamlined energy and Carbon Reporting Requirements, GOV.UK. Available at: https://www.gov.uk/government/publications/environmental-reporting-guidelines-including-mandatory-greenhouse-gas-emissions-reporting-guidance (Accessed: 25 March 2024).

[33] Source: Streamlined energy and carbon reporting (SECR) for Academy trusts (no date) GOV.UK. Available at: https://www.gov.uk/government/publications/academy-trust-financial-management-good-practice-guides/streamlined-energy-and-carbon-reporting (Accessed: 25 March 2024).

[34] Source: Source: SEC Adopts Rules to Enhance and Standardize Climate-Related Disclosures for Investors (2024) SEC.gov. Available at: https://www.sec.gov/news/press-release/2024-31 (Accessed: 25 March 2024).

[35] Source: Potential legal challenges to the SEC's climate disclosure rule (2024) Debevoise. Available at: https://www.debevoise.com/insights/publications/2024/03/potential-legal-challenges-to-the-secs-climate (Accessed: 25 March 2024).

[36] Source: California's New Climate Disclosure and GHG-related claims laws (no date) JD Supra. Available at: https://www.jdsupra.com/legalnews/california-s-new-climate-disclosure-and-5588883/ (Accessed: 25 March 2024).

[37] Source: Umano, R. et al. (2023) What's next for Japanese sustainability disclosure standards, EY US - Home. Available at: https://www.ey.com/en_jp/sustainability/whats-next-for-japanese-sustainability-disclosure-standards (Accessed: 25 March 2024).

[38] Source: Draft Disclosure framework on Climate-related Financial Risks, 2024 (no date) Reserve Bank of India - Database. Available at: https://www.rbi.org.in/Scripts/bs_viewcontent.aspx?Id=4393 (Accessed: 25 March 2024).

[39] Source: Segal, M. (2024) Singapore to introduce mandatory climate reporting beginning 2025, ESG Today. Available at: https://www.esgtoday.com/singapore-to-introduce-mandatory-climate-reporting-beginning-2025/ (Accessed: 25 March 2024).

[40] Source: McNally, F. (2024) Malaysia kicks off consultation on ISSB adoption, Responsible Investor. Available at: https://www.responsible-investor.com/malaysia-kicks-off-consultation-on-issb-adoption/ (Accessed: 25 March 2024).

[41] Source: GHG Protocol, Standards Update Process: Frequently Asked Questions.

[42] Source: GHG Protocol, Standards Update Process: Frequently Asked Questions.

[43] In 2023, Air Products, an S&P 500 company, issued the first green bond of any US chemicals company. Air Products' green finance framework includes reductions in Scope 3 emissions based on its product suite transition to include production of green and blue hydrogen.

[44] Source: Bloomberg, 2022 Bloomberg's Greenhouse Gas Emissions Estimates Model.

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