MEKETA
INVESTMENT GROUP

Minnesota State Board of Investments (SBI)

February 14, 2022

Climate Change Investment Analysis

Phase 1: Global Trends

Meketa Project Team
Project Director: Sarah Bernstein, Managing Principal, Consultant
Project Strategic Advisor: Allan Emkin, Managing Principal, Consultant
Ghiane Jones, Managing Principal, Consultant
Gordon Latter, Managing Principal, Consultant
Stephen MacLellan, Managing Principal, Consultant
Mark McKeown, Head of Fixed Income Research
Zach Stevens, Sr. Quantitative Analyst
Casey Satterlee, Sr. Investment Analyst
Cristen Xhama, Private Markets Analyst
Fabiola Bustamante, Performance Analyst
Jaclyn Schuppener, Sr. Client Service Assistant
Nat Barr, Client Service Assistant
Matthew Parla, Client Service Assistant

Table of Contents

Preface

The Minnesota State Board of Investments ("SBI"), as part of its oversight of the investment portfolio, continues to address the potential risks and opportunities of climate change on its portfolio. Meketa's Climate Change Investment Analysis project for the SBI seeks to provide data, analysis, and options for the SBI to further develop its investment strategy to address long-term climate investment risks and opportunities.

During year one of this project, Meketa intends to address these issues in three reports:

- In this first report, we review high-level global trends in climate change and related developments in financial markets across asset classes, policy and regulatory frameworks, institutional collaboration, and trends in climate risk data, metrics, and climate scenario analyses.
- Meketa plans to present Report Two at the May 2022 Investment Advisory Committee ("IAC") meeting. Report Two is designed to explore how public pension plan climate leaders address climate-related investment risks and returns. The report will include results of a survey of global public pension plan leaders in managing climate risks and opportunities and their approaches to investment strategies in line with the Paris Agreement. The survey results will provide the SBI a range of perspectives to consider on climate investment strategy as they determine the best course of action to pursue for the SBI Investment Portfolio.
- Report Three will analyze the SBI portfolio's current exposure to climate risks and opportunities throughout the total portfolio – public and private market investments - and discuss and provide options for the SBI to implement a successful climate transition strategy consistent with the terms of the Paris Agreement.

We thank the SBI for engaging Meketa to work on these critical issues and the SBI Staff for their insights and information.

Overview

As more governments, businesses, and investors seek to align their efforts with the Paris Agreement to reach a goal of net-zero emissions by 2050, there is increasing recognition that the climate crisis and evolving energy transition from fossil fuels to renewable sources carry ever growing material investment risks and opportunities.

Physical climate risk and the energy transition affect all parts of the economy. Long-term declines have begun in traditional fossil fuel energy markets. For companies that lag industry peers in the transition, the shift away from fossil fuels may pose material long-term business risks. However, this long-term decline is not occurring without cycles and shocks. The huge drop in fossil fuels with the economic collapse during the first year of COVID-19, followed by the rebound during which the market values of fossil fuel related companies surged, provides a recent example amidst growing recognition of the long-term decline. For companies aligning with a low-carbon economy, even with the benefit of very large long-term growth prospects, such companies also face traditional business risks, heightened technological change risks, and risks of supply shortages in key inputs.

Greenhouse gas emissions vary widely across industries and between companies within each industry. The complex nature of the transition and the difficulty of energy supply and demand transitioning in lockstep to meet net-zero goals in the timeframe identified by experts is already producing economic disruptions. The magnitude of the changes underway carry significant government policy and regulatory risks for both traditional companies and low carbon-focused companies. A growing number of companies that are in transition offer both traditional fossil fuel-driven and new low-carbon energy products and services. The current uncertainty of many government paths heightens the risks throughout the economy. It is important to underscore that traditional sources of energy will continue to be in demand to meet the diverse needs of business, the consumer, and government for the foreseeable future.

Within the institutional investor community, growing attention is devoted to identifying and managing the investment risks and opportunities that arise with physical climate risk and with the transition toward a low-carbon economy. The issues are complex, with no easy answers. In the US today, Meketa finds that most public pension plans do not address climate-related risk and opportunities explicitly in their investment strategy. Among asset owners that actively seek to address investment climate risks and opportunities, there is no established best practice on how best to tackle these issues.

Institutional investor strategies are evolving and will likely change significantly within the coming decade. Trends indicate that the early attention to climate focused on the publicly traded equity asset class and, at varying rates, has spread to all major asset classes. Climate data, metrics, and analytic tools are developing to assess climate risks and opportunities and align with net-zero ambitions. Attention is shifting to encompass the Scope 3 emissions of companies – emissions based a company's inputs and the emissions generated in the use of products after sale. Biodiversity impacts of climate change are commanding growing attention. The importance of economic and social stability of a just transition that supports those workers and communities most negatively affected, is gaining recognition. The realization that decarbonizing an investment portfolio, if disconnected from decarbonization in the real economy, does not address long-term climate risks. Strengthening collaborations among institutional investors is raising the importance of shareowner proxy voting and engagement with companies, asset managers, and governments in managing long-term investment climate risks.

I. Climate Change Global Outlook

Broadly defined, climate change is the variation in average weather conditions or patterns stretched out over an extended time, ranging from a few decades to millions of years. In today's context, the primary concern is the increasing temperature of the earth's atmosphere brought on by gases that trap heat, known as greenhouse gases ("GHG"). There are many GHG sources of global warming in nature, including natural forest fires, water vapor, and volcanos, which make up the overwhelming majority of GHG emissions. Bloomberg analyzed the impact of forest fires and their CO_2 impact in 2019 and determined that globally, forest fires were responsible for 7.8 billion (21%) of the 36.8 billion tons of carbon released from burning fossil fuels.[1] The current consensus within the scientific community is that human activity drives a critical portion of GHG emissions and is a primary cause of climate change today. The human component is a small percent overall but is large as an incremental factor and is the element that humans can strive to reduce. Leading climate scientists, such as Johan Rockstrom, Director of the Potsdam Institute for Climate Impact Research, find restricting warming of the earth to no more than 1.5 degrees Celsius above pre-industrial levels by 2050, at the latest, is an essential physical threshold to avert the risk of irreversible, devastating environmental upheaval. Meeting these goals requires GHG emissions, much of which are carbon emissions, to drop by half by 2030 and reach net-zero emissions (removing as much CO_2 from the atmosphere as is being generated) by 2050 or sooner.

Based on 2019 data, the US Environmental Protection Agency estimates that carbon dioxide ("CO_2") accounts for 80.0% of all GHG emissions and primarily makes its way into the atmosphere from the burning of fossil fuels (coal, natural gas, and oil), solid waste, biological material, and through certain chemical reactions.[2] Additionally, CO_2 remains in the atmosphere the longest, with about three-quarters of it dissolving into the ocean over a few decades and the remainder taking hundreds to even thousands of years to eliminate.[3] The GHG methane accounts for approximately 17% of annual GHG emissions. However, methane has about 28 times the warming power of CO_2 per one ton over a 100-year period. Although methane has much stronger warming potential than CO_2, it remains in the atmosphere for less time – about 12 years.

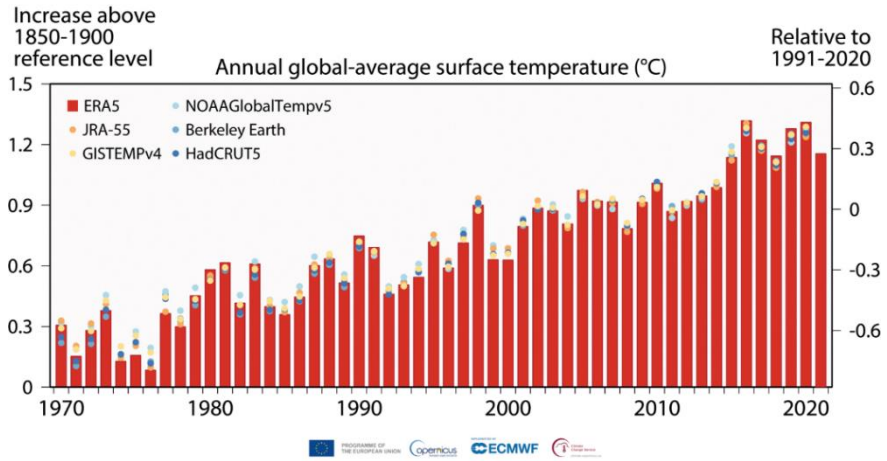
One consequence of these emissions is global warming. Since 1880, the 10 warmest years measured all occurred after 2005. The last seven years rank as the top seven hottest, as shown below.

[1] https://www.bloomberg.com/graphics/2020-fire-emissions/

[2] Source: https://www.epa.gov/ghgemissions/overview-greenhouse-gases

[3] https://blogs.edf.org/climate411/2008/02/26/ghg_lifetimes/

Figure I.1[1]



Global warming is not an isolated risk factor that affects a subset of people, countries, or companies. It has, and will continue to, change how economies and industries operate. Rising temperatures already affect many lives. Many believe that the time seems to be rapidly approaching when the damage becomes so severe that future generations may not have the opportunity to course correct.

Attribution studies link climate change to rising trends in extreme weather. Carbon Brief analyzed several hundred of these studies and found that in a majority of cases, human-related climate change either increased the likelihood of or exacerbated the effects of extreme weather events.[2]

In August 2021, the United Nation's ("UN") Intergovernmental Panel on Climate Change ("IPCC") released their Sixth Assessment, a special report[3] that reviewed the most up-to-date data and physical science understanding of climate change and outlines how humans have contributed to global warming. The report finds: "it is unequivocal that human influence has warmed the atmosphere, oceans and land." The study warns that, without rapid and large-scale reductions in GHG emission, global temperatures will reach or exceed 1.5°C of warming above pre-industrial levels in the next two decades. This level of warming would lead to catastrophic natural disasters like more extreme heatwaves, droughts, and flooding around the world. This report is the first major review of the science of climate change since 2013.

The uptick in extreme weather events has a spillover effect on biodiversity. As an example, forests across the globe have been devastated as wildfires increase. Forests play a crucial role in CO_2 absorption across the globe. The UN IPCC forecasts a temperature increase of 2.6-4.8°Celsius by 2100.[4] A study found that if emissions continue rising at their record-breaking rate, one in six of all the world's species face the risk of extinction.[5]

[1] Source: https://climate.copernicus.eu/copernicus-globally-seven-hottest-years-record-were-last-seven

[2] Source: https://www.carbonbrief.org/mapped-how-climate-change-affects-extreme-weather-around-the-world

[3] Source: Climate Change 2021: The Physical Science Basis

[4] Source: https://eciu.net/analysis/briefings/climate-science-the-basics/climate-change-and-nature

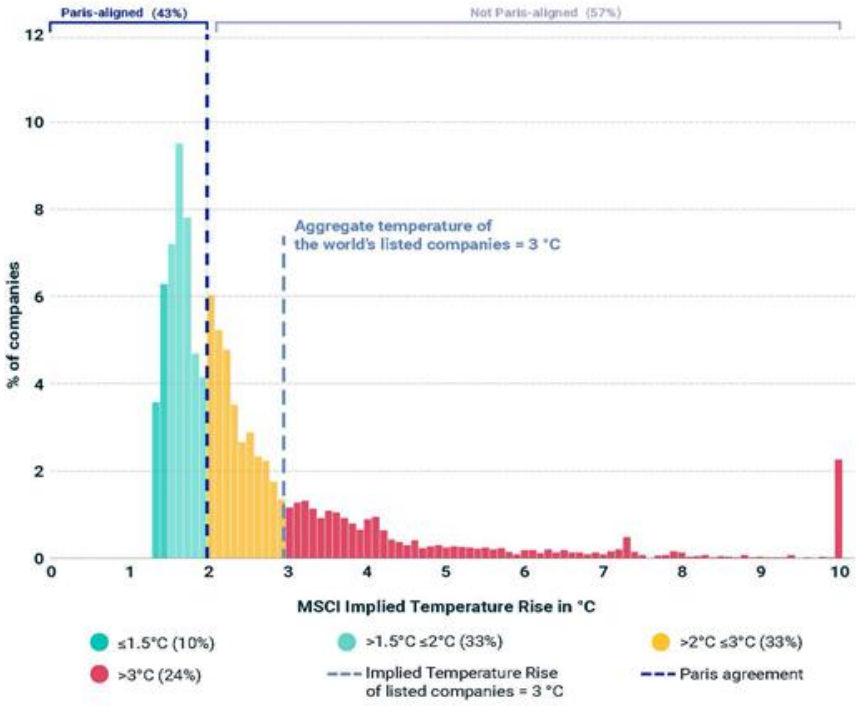
[5] Source:https://www.theguardian.com/environment/2015/apr/30/one-in-six-of-worlds-species-faces-extinction-due-to-climate-change-study

II. Energy Transition

Long-term secular trends indicate an acceleration in the transition away from carbon-based energy to renewables. In the net-zero emissions pathway presented in the International Energy Agency (IEA) 2021 report, in 2030 the world economy will be 40% larger than today but use 7% less total energy, accomplished in large part by major advancements in energy efficiency. The report estimates a significant decline in the use of fossil fuels with these shifts. The IEA 2021 report predicts that a push towards net-zero will result in energy supply generated from fossil fuel decreasing from 80% of total energy supply today to just over 20% of total energy supply by 2050.

The Paris Agreement aims to limit global temperature rise to well below 2°C, and preferably to no more than 1.5°C. Evidence on whether companies have credible plans to reduce their emissions in line with the Paris Agreement goals or 'net-zero' emissions by 2050, shows that most companies globally are not aligned with 1.5°C. For example, MSCI analyzed the 9,226 constituents (as of September 20, 2021) of the MSCI ACWI Investable Market Index ("IMI"). The MSCI ACWI IMI covers approximately 99% of the global public equity investment opportunity set. In the MSCI Net-Zero Tracker of October 2021, they report that listed companies are on track to cause average temperatures to rise by nearly 3°C above pre-industrial levels. Less than half (43%) of listed companies align with a 2°C temperature rise and less than 10% of listed companies align with a 1.5°C temperature rise, as shown in Figure II.1.

Figure II.1[1]



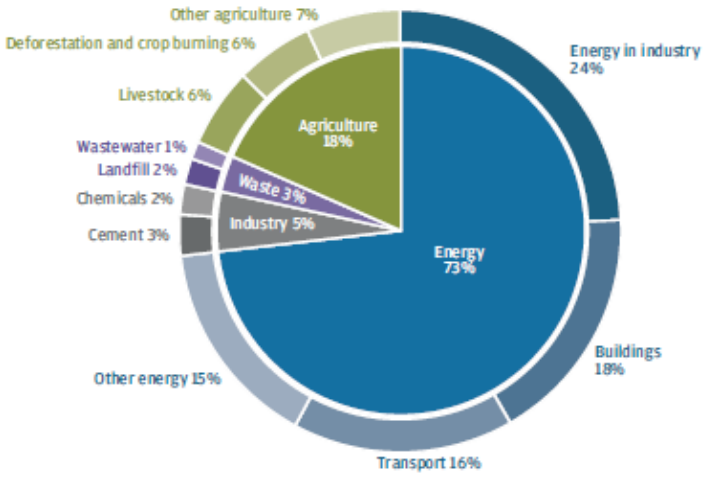
[1] Source: https://am.jpmorgan.com/content/dam/jpm-am-aem/emea/regional/en/insights/market-insights/otmoi/mi-otmoi-the-path-to-net-zero-emissions.pdf

GHG emissions have increased about 50% since 1990. With GHG emissions and temperatures continuing to rise at unprecedented levels, we face a shorter timeframe to address climate issues than previously anticipated.

High Emitting Sectors

Carbon emissions vary widely by economic sector and geography. From a sector perspective, the energy and industrial sectors have contributed most to the rise of global emissions since 1990, with GHG emissions up 56% and 180%, respectively. The increase in the agriculture sector has been more muted (16.5%), although the types of agriculture emissions are often more environmentally damaging. As shown in Figure II.2, power generation, transport, and buildings are the sectors that emit the most CO_2 and, accordingly, are where the most innovation and new regulation are expected.

Figure II.2– Global Greenhouse Gas Emissions by Sector[1]



Greenhouse gas emissions include CO_2, methane, nitrous oxide, and fluorinated greenhouse gases. CO_2 equivalent tons standardize emissions to allow for comparison between gases. One equivalent ton has the same warming effect as one ton of CO_2 over 100 years. Past performance is not a reliable indicator of current and future results. Data as of 31 March 2021.

There are high-emitting companies in every sector. To measure emissions in a standard framework, the GHG Protocol defined three scopes of emissions. In addition to variation among industries in their absolute level of emissions, industries differ markedly in the proportion of Scope 1, 2, and 3 emissions. The scopes correlate to who 'owns' those emissions and the level of control applicable to changing those emission levels at each stage. Today, Scope 1 and 2 emissions are a mandatory part of reporting for many organizations across the world and relate to systems that are within reasonable control of an entity, such as onsite and purchased energy.

Scope 1 emissions are defined as direct emissions. Scope 1 emissions include emissions generated directly from operations owned or controlled by the reporting entity. Scope 2 is defined as indirect GHG emissions from the generation of purchased or acquired electricity, steam, heating, or cooling consumed by the reporting entity.

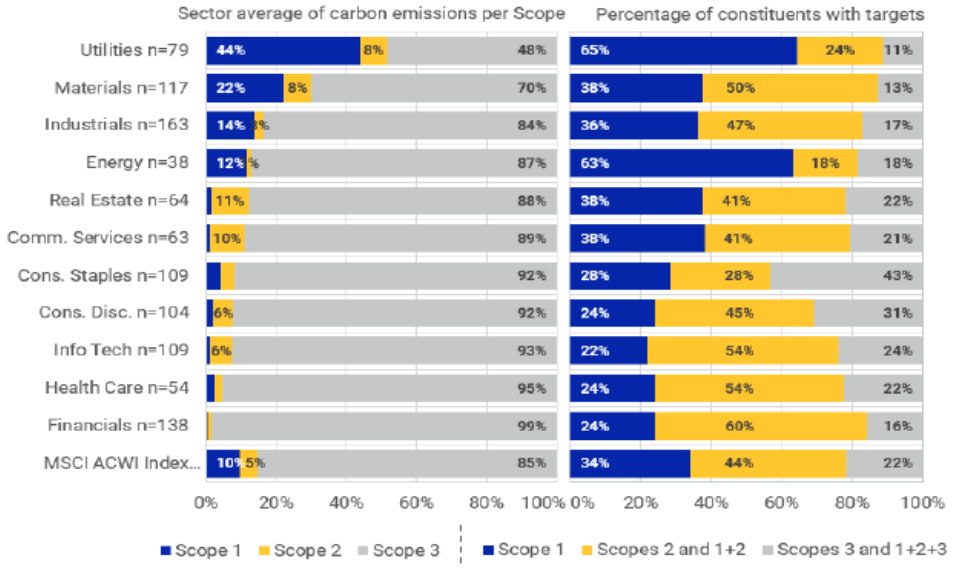
[1] Source: Climate Watch, Our World in Data, World Resource Institute, J.P. Morgan Asset Management.

Scope 3 emissions include all other indirect emissions that occur in a company's value chain of creating end products, beginning with sourcing the raw materials, and continuing through manufacturing, transporting, and use of the product. Scope 3 emissions remain mostly voluntary to report. In many industries, the reduction of Scope 3 has the potential to have the largest impact on overall emissions reduction. As illustrated in Figure II.3, Scope 3 emissions account for the great majority of total emissions in most sectors, including high emitting sectors such as energy, technology, and consumer discretionary, which includes transportation.

Figure II.3 illustrates the sector differences in proportions of Scope 1, 2, and 3 emissions. The left-hand column graphs by sector average carbon emissions per scope. For example, the airline industry generates predominately Scope 1 emissions. The emissions from using jet fuel in the operation of providing travel services result in Scope 1 emissions that often account for two-thirds or more of an airline's total emissions. Energy utilities, by the nature of the service they provide, include a high percent of Scope 1 emissions. Scope 1 emissions currently account for an estimated average 44% of total emissions for the utilities sector. Real estate exhibits very little Scope 1 emissions. Scope 2 emissions account for 11% of total real estate emissions on average, and Scope 3 emissions accounted for nearly 90% of total emissions. For the energy sector, Scope 3 emissions account for 87% of total emissions. Energy sector Scope 3 emissions include those emissions released when sold products are used, such as combustion of aviation fuel in aircrafts, gasoline in car engines, or sold to energy utilities.

Measuring carbon emissions provides a starting point for understanding where the greatest risks in addressing climate change lie. Tracking the carbon targets of companies provides an indication of potential for improvements, as shown in the right-hand column in Figure II.3.

Figure II.3 – Scopes of Carbon Emissions (left) and Targets (right) by GICS Sector[1]



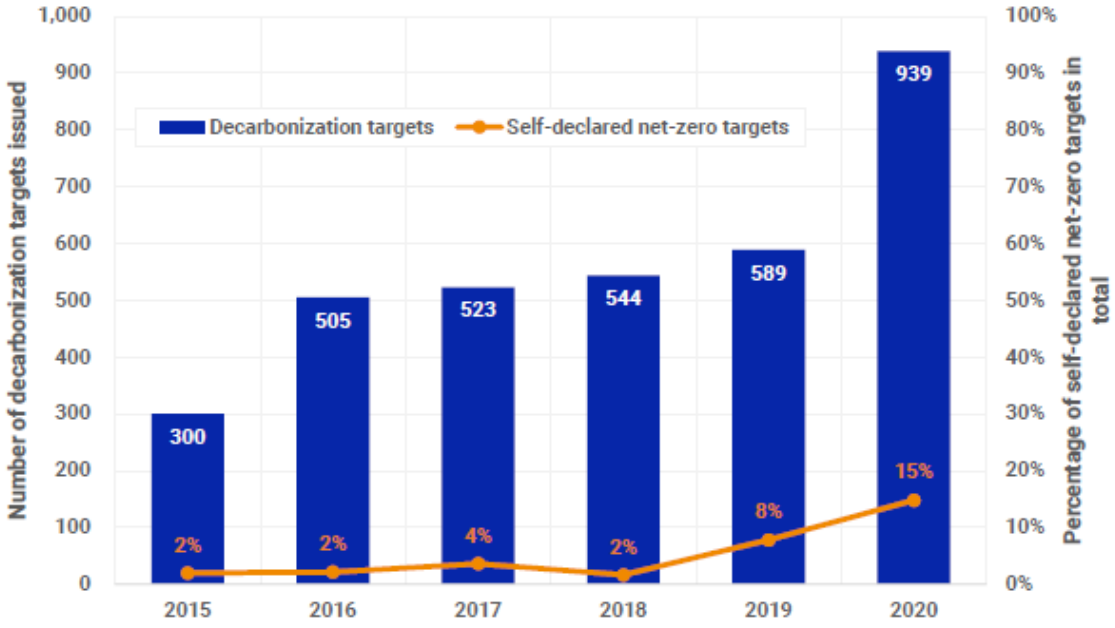
This research used two-digit codes to define each GICS sector peer set. Total carbon emissions of each sector comprise Scope 1, 2, and 3 emissions. Scope 1 and 2 emissions were reported by the companies or estimated by the MSCI Climate Change Metrics Methodology. Scope 3 emissions were estimated by the MSCI Scope 3 Carbon Emissions Estimation Methodology, which is aligned with the GHG protocol. Scope 2 targets included energy consumption reduction targets. When multiple targets existed, the scope of final target year was represented in the chart. Source: CDP. MSCI ESG Research. as of January 5, 2021

[1] Source: MSCI.

Among MSCI ACWI Index constituents, emissions targets align fairly well with the dominant Scope type of emissions in sectors dominated by Scope 1 emissions. For example, 65% of the targets set by companies in the utilities sector focused on Scope 1 emissions, which was the dominant scope (44%). In contrast, in sectors dominated by Scope 3 emissions, targets are often misaligned. For financials, where 99% of emissions came from Scope 3, only 16% of targets covered Scope 3 emissions. The energy sector's emissions were 87% Scope 3, while only 18% of the energy sector constituent's targets addressed Scope 3 emissions. Addressing Scope 3 emissions for an energy company requires reducing the fossil fuel-based energy products the company sells.

The number of companies setting decarbonization targets has increased recently, growing to 939 of the MSCI ACWI constituents in 2020 from 589 in 2019, as shown in Figure II.4. The number of constituents with self-declared net-zero targets reached 15% of the total number of companies with decarbonization targets.

Figure II.4 – Number of Companies that Set or Added Decarbonization Targets[1]



The changes in climate already underway are systemic and affect all economic sectors. **Reducing both the supply and demand for fossil fuels is essential to creating a low carbon economy**. Energy sector dynamics indicate interconnected and critical nature of changes required throughout the economy. Reductions in the supply of fossil fuels, without reductions in demand, can be counterproductive to the long-term energy transition and contribute to shortfalls and record energy prices, as currently occurring in Europe. Countries wrestle with balancing economic health with the speed of the energy transition, in some situations leading to near-term increases in fossil fuel energy, including coal, which is often relatively inexpensive in some regions compared to renewables, even if the country's long-term goals are a net-zero emissions by 2050 or thereabouts.

[1] Source: MSCI.

Demand for fossil fuel energy includes industries that are very difficult to decarbonize and currently generally rely on high levels of burning fossil fuels. Seven difficult-to-decarbonize industries currently account for 30% of GHG emissions – concrete, steel, aluminum, chemicals, and the transport that supports the global economy – ships, planes, and trucks. Industry, academia, the financial industry, and government are all committing significant resources to seek ways to make those industries more efficient and less energy intense.

Increased regulations and demand from consumers are spurring change. Fossil fuel reserve owners and the traditional energy sector increasingly face headwinds in the form of government and corporate climate policies, and global demand shifting to renewable sources of energy. Transition efforts are growing even in high-emitting sectors, including for industries with emissions that are very hard to abate. New energy transition industries are rapidly growing, even as new technologies create changes in products. The pace of growth is bringing potential bottlenecks in supplies, such as in key minerals used in battery storage.

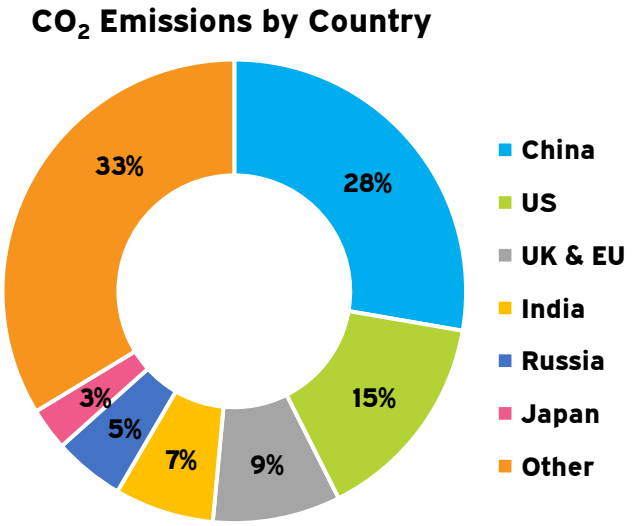
Scope 1 and 2 emissions can dramatically change at the company level by outsourcing production and thereby transferring the associated emissions to another owner. One example is Apple, which has transformed its data centers to run on renewable energy. Apple outsources the production of its phones and therefore has minimal Scope 1 and 2 emissions. Apple exemplifies a successful, large global company that cannot reduce its significant Scope 3 emissions without setting and achieving emissions targets for the company's suppliers.

Companies in sectors with lower total emissions are also beginning to transition. For example, McDonalds and eBay co-signed a deal pledging to produce 345 megawatt ("MW") of solar power in Louisiana, the state's largest solar project to date. Microsoft recently committed to providing 250MW of solar power to underserved minority and rural communities, while Walmart pledged as the "anchor tenant" supporting 129MW of community solar projects. Plug Power signed a power purchase agreement for 345MW of wind turbine power to use to create liquid hydrogen, the first and largest wind-powered hydrogen plant in the US.

High Emitting Geographies

Geographically, the sources of emissions continue to shift. In 1900, Europe and the US produced over 90% of CO_2 emissions. The latter half of the 20th Century witnessed a significant rise in emissions from Asia, in conjunction with economic growth, particularly in China. As shown in Figure II.5, for 2019, China, India, and Japan accounted for nearly 40% of the world's CO_2 emissions. Together, China, the US, the United Kingdom ("UK"), and the European Union ("EU"), India, Russia, and Japan accounted for two-thirds of worldwide emissions, with the rest of the world accounting for the remaining third.

Figure II.5 – Share of Global CO2 Emissions by Country, 2019[1]



As nations grapple with setting net-zero targets, a central issue concerns the abilities of developed and emerging countries to transition. From a historical perspective, carbon emissions declined in developed markets in part because multinationals relocated production (and their carbon emissions) to emerging markets. These dynamics allowed high-income economies to start their energy transition earlier. As emerging markets were later to industrialize, most emerging markets are not responsible for the bulk of global emissions to date. As of 2019, the US had emitted more CO_2 emissions than any single country on earth and contributed 25% of historical emissions since the Industrial Revolution. The second largest contributor to historical CO_2 emissions is China. The lowest geographical contribution region is Africa, both historically and currently.[2] Going forward, the drive to decarbonize in developed markets could spur more emissions in emerging markets, partly from the expected increase in demand for a range of raw materials that are critical to low-carbon technologies (e.g., lithium, nickel, cobalt, manganese, and graphite) most of which are today mined in emerging markets. From a policy perspective, this illuminates the need for internationally interconnected approaches to climate policy development across regions, to avoid enacting GHG emissions reduction policies in one country or region that inadvertently raise overall global emissions.

[1] Source: Gapminder, Global Carbon Project, Our World in Data, United Nations, J.P. Morgan Asset Management.

[2] Source: https://ourworldindata.org/co2-emissions

III. Climate Change and Financial Markets

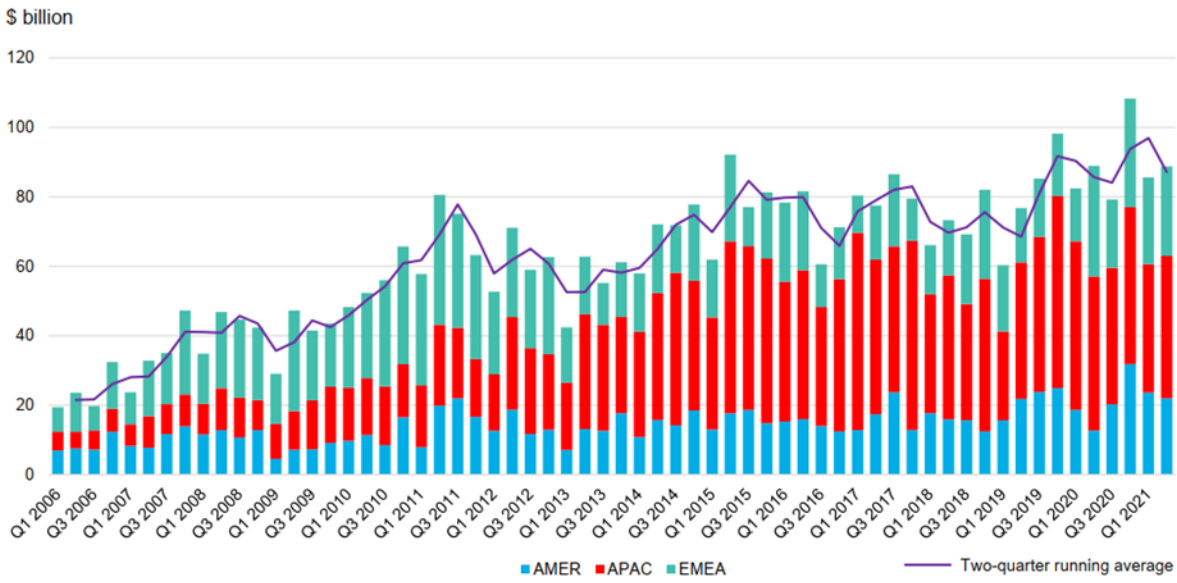
The accelerating transition to renewable energy and the escalation of physical climate risks is contributing to significant change in global financial markets. Sustainable investment assets grew to $35.3 trillion globally in 2020 according to Bloomberg, 14% of total global investable assets which totaled $250 trillion in 2020.[1] This figure accounts for all investment funds that integrate environmental, social, and governance ("ESG") factors into their investment process, not just funds explicitly designed for a quantifiable environmental impact. The same report estimates that approximately $25 trillion of these assets are invested in funds that integrate ESG into their financial modeling, so managers may be taking ESG into consideration in their investment process, but not necessarily changing investments on these considerations.

Figure III.1: Growth in Sustainable Investing Assets

Over the past decade, investors increased investments in renewable energy projects. (See Figure III.2). Renewable energy cost reductions, technological innovations, and government subsidies helped support attractive value propositions.[2] As the energy transition progresses, the nature and extent of government subsidies is likely to change. Governments may introduce new, increase and/or roll back renewable incentive programs that in some cases began when renewable energy was a nascent industry. As of 2021, 27 countries, and 11 states in the US have adopted some form of carbon pricing mechanism. Carbon pricing may further accelerate the transition to a low-carbon economy.

[1] https://www.institutionalinvestor.com/article/b1s6dsvw696kqd/Global-Investable-Assets-Reach-Record-250-Trillion
[2] https://data.bloomberglp.com/promo/sites/12/678001-BNEF_2020-04-22-ExecutiveFactbook.pdf?link=cta-text

Figure III.2 – New Financial Investment in Clean Energy by Region ($ billions)[1]



The cost of de-carbonization is expected to continue to decline long-term, driven by technological and financial innovations, growth in market adoption, and supportive government policies. For example, Goldman Sachs finds that consistent application of low-cost, de-carbonization technology improvements at scale, breakthrough clean hydrogen technologies, financial innovations, and a lower cost of capital for low carbon activities can, in aggregate, reduce the annual costs of the path to net-zero by roughly $1.0 trillion. This cost reduction is approximately a 20.0% improvement over their 2019 Carbonomics cost curve estimate. Goldman Sachs finds financial conditions tightening for hydrocarbon developments, leading to hurdle rates 20.0+% for long-cycle oil developments, while low carbon projects, such as renewable power investment financing, have hurdle rates in the range of 3.0%–5.0%.[2]

These developments are accelerating as large investors, banks, and market participants, including large commodities traders, are increasing their low carbon financial exposures. Recently, the world's four largest oil traders reportedly began efforts to invest billions of dollars in renewable energy projects over the next five years.

Investor demand has led to a growing number of investment funds that seek to meet or exceed market financial returns and achieve a quantifiable climate impact. This includes thematic funds in public and private markets, such as those with investment strategies focused on water to climate technology, to broader energy transition mandates.

In addition to specific "green" or ESG-focused fund options, a growing number of investment funds incorporate ESG factors without labeling their investment product green, sustainable, or ESG-focused. As underlying companies begin to shift their focus to be more climate friendly, the broad investable universe for managers inevitably becomes "cleaner." Climate-specific developments continue to escalate. December 2020 saw the launch of the Net-Zero Asset Managers Initiative, a collection of currently 128 asset managers that oversee $43 trillion in AUM who pledged to support investing aligned with net-zero carbon emissions by 2050 or sooner.

[1] Source: BloombergNEF.

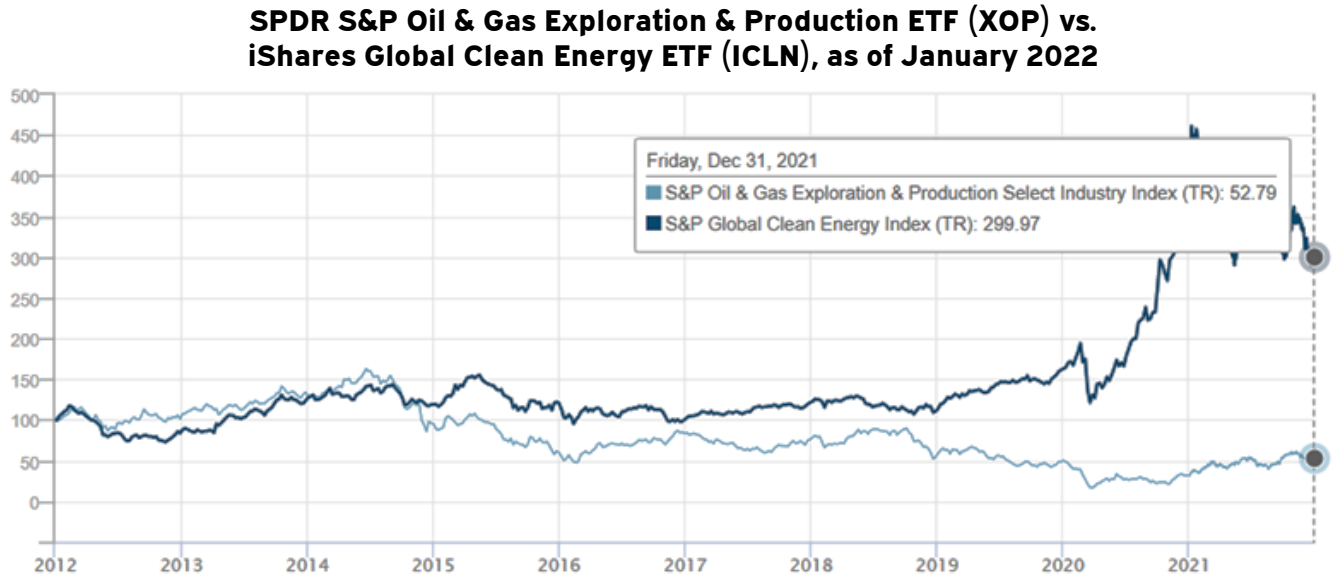
[2] Source: "Carbonomics Innovation, Deflation and Affordable De-carbonization", Goldman Sachs, October 13, 2020.

Public Equity Market Trends

Trends in equity indexes indicate that long-term declines in fossil fuel energy and long-term growth in clean energy valuations also include near-term volatility embedded in energy prices and economic activity, as occurred in 2021 with the very strong run up in oil, gas, and coal.

The S&P Global Clean Energy Index compared to its Oil and Gas Exploration and Production index illustrates the volatility and long-term shifts. As shown in Figure III.3 below, the S&P Clean Energy Index value outpaced that of the S&P Oil and Gas Exploration and Production Index since early 2018, with clean energy more than doubling in value in 2020, while Oil and Gas Exploration and Production lost approximately 35%. However, the pickup in the global economy coming out of the pandemic in 2021 reversed the clean energy trend direction. Oil, gas, and coal rebounded throughout 2021 with the economic recovery and, with insufficient renewable energy to meet demand, even in countries actively transitioning to renewables.

Figure III.3: Clean Energy vs. O&G Exploration and Development Market Values[1]



Recent changes in the composition of the Clean Energy Index illustrate the lack of maturity of the sector, investor demand, and rapid developments within clean energy. For example, the largest exchange-traded funds ("ETF") in the space, BlackRock's iShares Global Clean Energy, brought in more than $2.8 billion since the start of 2021. The iShares fund tracks the S&P Global Clean Energy Index, which held just 30 names as of April 2021. The large inflows in ETFs led to an overhaul of the benchmark, as too much money chased too few stocks. There are now 81 names instead of 30 in the index, and the number of names continues to grow. Adding names increased liquidity and diversity. It also included companies with a wider range of clean energy and brought the "clean energy exposure" score of the index down. S&P believes the clean energy score will return to its prior level as they add more names, especially from emerging markets.

[1] Source: S&P Dow Jones Indices.

The long-term energy sector's shift in its share of market capitalization in major indices mirrors trends in energy sector index returns. As shown in Figure III.4, both the Russell 1000 and the Russell 3000 indexes drops in market share occurred in the energy sector, the oil and gas industry and the coal sub-industry. These drops reflect the extraordinary growth in valuations of a few huge global technology companies, including Facebook, Amazon, Netflix, Google, and Apple, which have dwarfed growth in every part of the public equity markets. The energy rally in 2021 brought an increase in market share for fossil fuel companies compared to 2020.

Figure III.4 – Russell 1000 and Russell 3000 Energy Sector Market Share[1]

% of Russell	R1000			R3000		
	Sector Energy (%)	Industry Oil&Gas Con Fuel (%)	Sub-Ind Coal and Con Fuels (%)	Sector Energy (%)	Industry Oil&Gas Con Fuel (%)	Sub-Ind Coal and Con Fuels (%)
30-Sep-10	10.65	10.33	0.33	10.21	9.87	0.32
30-Sep-15	6.66	6.62	0.01	6.34	6.28	0.02
30-Sep-20	2.01	1.92	0.00	2.02	1.90	0.01
30-Sep-21	2.74	2.62	0.00	2.87	2.71	0.01

The long-term trend of declining market share of fossil fuel companies in indexes incorporates both the decline in market capitalization of fossil fuel companies and a reduction in the number of fossil fuel companies included in the index. The reduction in the number of fossil fuel companies in broad indexes can reflect mergers, companies going out of business or going private, and the removal of some energy sector companies from an index. For example, since 2011, the US alone retired 60% of all US-based, coal-fired power plants.[2] The S&P Dow Jones Industrial Average announced on August 25, 2020, that it would remove its longest tenured constituent, ExxonMobil, due to its poor performance and negative investor sentiment. Exxon was the most valuable publicly traded company in the world as recently as 2013. The May 2021 ExxonMobil shareholder vote led by small climate transition activist hedge fund Engine No. 1 saw three of its four nominees join the Exxon Board. The vote was unprecedented and a sign that institutional investors are increasingly willing to force corporations to actively participate in that transition.

Public equity fossil fuel free and climate transition indexes outperformed market-cap weighted parent indexes, as illustrated in Figure III.5 for both MSCI World and S&P 500 indexes in recent years. For the periods ending December 31, 2021, fossil fuel free indexes performed marginally better than the parent indexes over the 3-year and 5-year trailing periods. The risk profiles of climate transition indexes and ex-fossil fuel indexes were very similar to their parent benchmarks, often with slightly lower risk. Climate transition indexes assign higher weights to companies across the economy that align better with the Paris Accord. These indexes outperformed their parent indexes and the ex-fossil fuel indexes. Low-carbon indexes such as the MSCI World Low Carbon Target and the S&P500 Carbon Efficient indexes, exhibited slightly higher returns, and higher risk, than the parent indexes for these periods, reflecting in part the impact of a small group of huge global technology companies.

[1] Source: Russell.

[2] Source: https://www.sierraclub.org/press-releases/2020/09/bloomberg-philanthropies-and-sierra-clubs-beyond-coal-campaign-reaches

Figure III.5: Climate Index Annualized Returns Compared to Core Parent Market Cap Indexes

Annualized Risk Return Statistics
(Periods Ending December 31, 2021)[1]

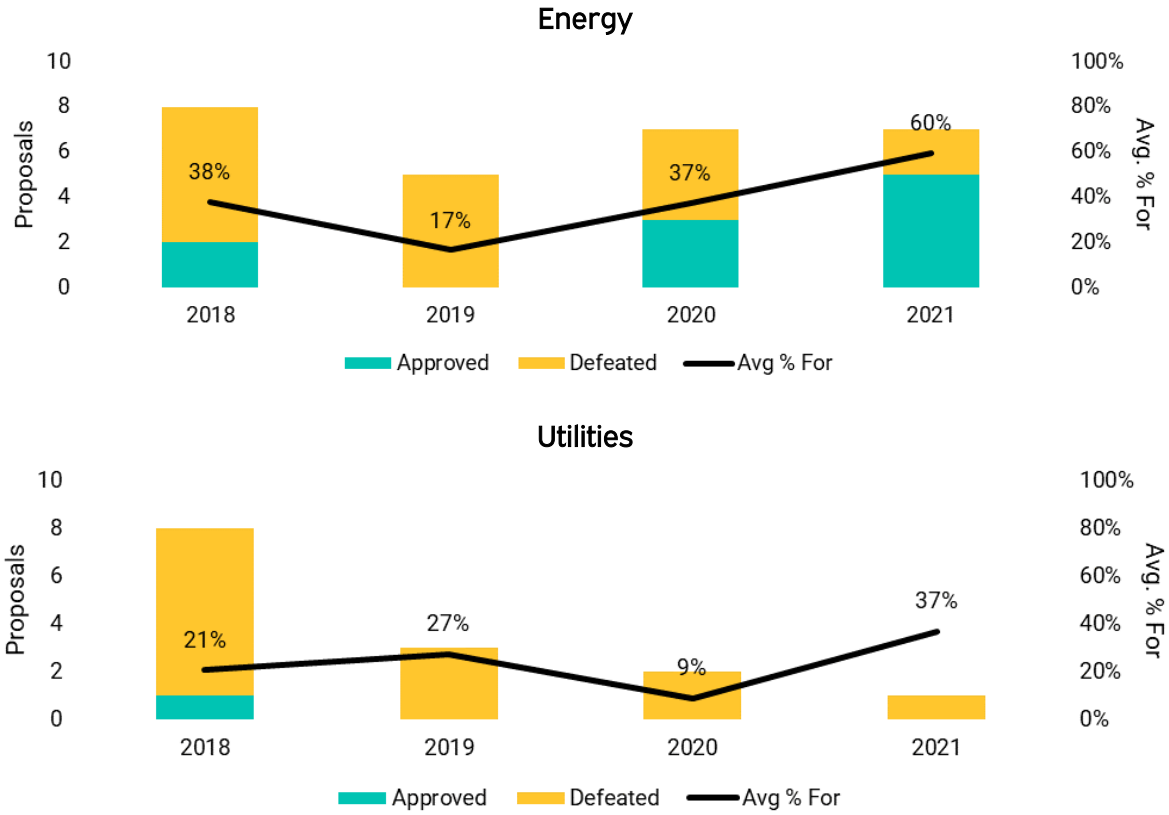
Name of Index	No. of Firms	Weighted Avg Mkt Cap ($B)	Return 3-Yr (%)	Return 5-Yr (%)	Risk (Std Deviation) 3-Yr (%)	Risk (Std Deviation) 5-Yr (%)	Sharpe Ratio 3-Yr	Sharpe Ratio 5-Yr	Tracking Error 5-Yr (%)
MSCI WORLD	1,546	418.8	22.3	15.6	17.3	15.0	1.20	0.96	-
Ex-Fossil Fuels	1,469	433.5	23.3	16.4	17.0	15.8	1.26	1.02	0.7
Low Carbon Target	1,267	393.3	22.7	15.8	17.4	15.1	1.21	0.97	0.3
Climate Paris Aligned	655	364.9	23.7	17.0	17.1	14.8	1.28	1.05	1.2
S&P 500	505	597.8	26.1	18.5	17.4	15.4	1.50	1..20	-
Fossil Fuel Free	489	607.8	26.8	19.2	17.2	15.3	1.56	1.26	0.7
Carbon Efficient	490	653.4	26.2	18.5	17.6	15.5	1.49	1.19	10.6
Net Zero Climate Transition	371	668.9.	28.6	20.1	17.3	15.4	1.65	1.31	1.1

While sustainability has become mainstream in financial markets, there are a wide variety of approaches, little standardization in disclosure, and regulatory guidance is generally just emerging. There are some equity climate opportunity funds that outperformed where the bulk of outperformance was driven by a residual missing factor, a systemic, as opposed to stock specific 'climate beta' factor that is not accounted for by traditional fundamentals such as size, momentum, growth, quality, sectors, and country-related factors. For example, LA Capital finds that climate has evolved to be a driver of return and can be additive to an existing set of traditional fundamental factors and to a broad ESG factor.

A key trend in public equity markets is the growing attention to proxy voting and engagement, particularly regarding disclosure and management of climate risks and Paris Alignment. The percentage of proxies voted in favor of stronger climate risk disclosure and management rose from 2018 to 2021 in both the energy and utilities sectors, as shown in Figure III.6.

[1] Sources: MSCI and S&P Dow Jones Indices.

Figure III.6 – Proxy Voting Trends on Climate in Energy and Utilities Sectors[1]



The chart shows the number of defeated and approved climate-related shareholder proposals in the US energy and materials sectors (left scale) and the average percentage of votes in favor (right scale).

The growing attention to the need to achieve net-zero carbon real economy emissions as quickly as possible and no later than 2050 is shifting investor attention to creating a better "market beta" through decarbonization, with the aim of minimizing the overall negative costs to the global economy and to investors, thus better aligning their interests.

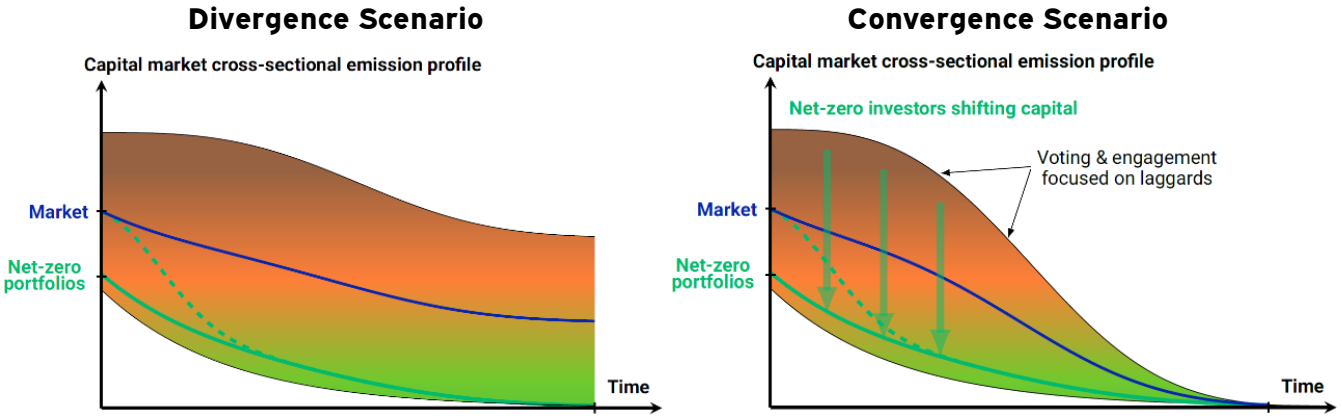
Trends indicate that the early focus on divestment of fossil fuel companies has evolved. With the focus on net-zero real economy solutions, many market participants have evolved beyond simplistic blanket fossil fuel exclusions. More investors use divestment strategically – shifting their exclusion criteria to focus, not on historic measures of emissions exposure, but on forward-looking transition strategies, thereby supporting companies that are actively transitioning. Investing in climate solutions across the economy is becoming a larger aspect of climate strategies as investment opportunities increase. More effort and attention are being devoted to proxy voting and engagement.

Central issues for net-zero-designed portfolios include the potential 'divergence' between investor net-zero results and real economy net-zero results across all sectors if investors focus only on finding climate alpha opportunities. For example, as illustrated in Figure III.8, MSCI finds that a focus only on pure climate opportunities can result in a global economy in which only some companies become

[1] Source: MSCI ESG Research.

net-zero, and only concentrated investment portfolios that focus on net-zero leaders would be able to reach net zero. Diverging from these concentrated portfolios, the broad market and the economy at large would incur the high costs of no widespread, timely transition (monetary, human, and environmental). In contrast, a net-zero focus on both investing in leaders and creating a better market beta, could drive a 'convergence' scenario in which net-zero investors lead the broad market and the overall market follows hopefully bringing the global economy to net-zero before 2050.

Figure III.7 – Net-Zero Investment Portfolios that Diverge or Converge with Net-Zero Real Economy[1]



The complex nature of the global energy transition across industries and geographies raises the potential for conflicts and for net-zero strategies by governments and private market participants that can inadvertently work against a global transition to net-zero. These concerns suggest that forward-looking, transition metrics, rather than static carbon emissions may be a central element to developing net-zero investment strategies.

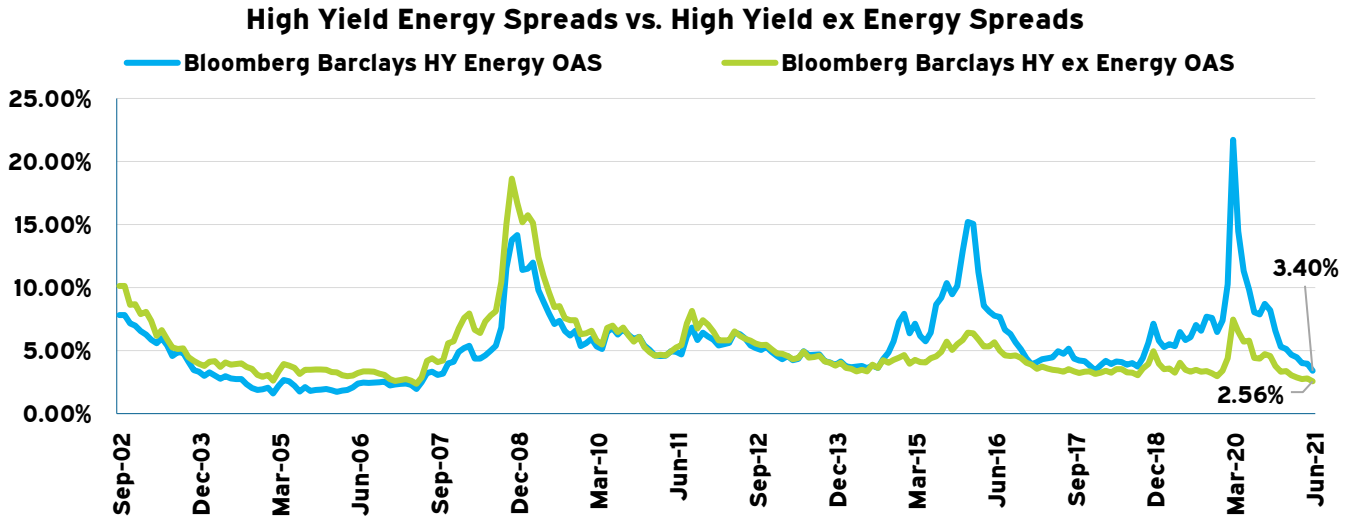
Fixed Income Trends

Climate transition trends, and volatility, are evident in fixed income markets in credit spreads between traditional energy and the overall high yield market, and the rapid growth in climate and sustainability related bonds.

As shown in Figure III.8 below, credit spreads for energy sector constituents within the Bloomberg Barclays High Yield Index traded wider to the broader market since 2014, widened to higher peaks following the onset of COVID-19 in early 2020 but then dropped sharply since the end of June 2021 with the rebound in oil, gas, and coal.

[1] Source: MSCI ESG Research.

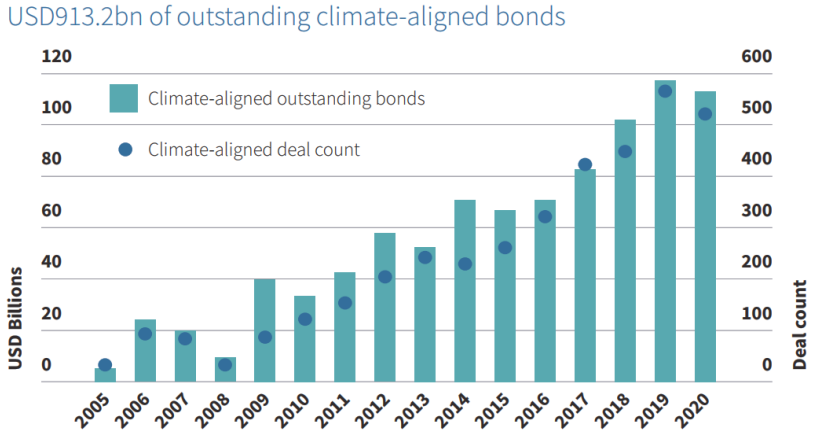
Figure III.8 - High Yield Energy Spreads compared to Market High Yield ex-Energy Spreads[1]



The bond market includes climate related bonds that are labelled ("Green Bonds") and bonds that are climate aligned but unlabeled. The Climate Bonds Initiative ("CBI") tracks bond issuers financing of labelled and unlabeled climate-aligned assets. At the end of Q3 2021, green bond issuance for the calendar year stood at $354 billion, surpassing the 2020 record. The total volume of labeled green bonds comprises one part of an overall total universe that CBI reports at $1.7 trillion, encompassing bonds labeled green, transition, pandemic, social, SDGs, and sustainability.

The 2020 CBI report on unlabeled climate aligned bonds identified 420 climate-aligned issuers (issuers that derive at least 75% of their revenues from climate-aligned business activities) with 311 of those being fully aligned issuers (issuers that derive 95% or more of their revenue from climate-aligned activities). CBI calculates there is currently $913.2 billion in outstanding unlabeled climate-aligned bonds (Figure III.9), with an emphasis on corporate issuers.

Figure III.9 – Climate Aligned Unlabeled Bonds[2]



[1] Source: Bloomberg Inc.

[2] Climate Bonds Initiative.

Transport companies held the lion's share of the market, accounting for over 50% of climate-aligned bond issuance globally. Geographically, China was by far the largest issuer, representing 36% of the global total. France, the US, South Korea, and the UK round out the top five, with China and France together accounting for more than half of the total climate-aligned universe.

The increase in green bond issuance has yet to be directly associated with a reduction in carbon intensities. For example, the Bank of International Settlements released a report in September 2020 that found "no strong evidence that green bond issuance is associated with any reduction in carbon intensities over time at the firm level." The report clarifies that these results do not indicate that green bonds failed to meet their intended environmental goals, but, rather, that the firms that issued these bonds did not exhibit a meaningful difference in their carbon intensity. The report suggests that like credit rating buckets or classifications, firm-level ratings could better deliver on climate change goals than the current project-based system.[1]

To date, there is little to no standardization for reporting and disclosures of climate related bonds. The definition of "green" assets and activities varies across countries and companies, allowing issuers to label a bond as "green" without having to report where the funds are being used, a version of greenwashing in the bond market. The issuers for about half of the municipal green bonds sold in 2021 self-designated the bonds as green bonds, rather than certifying the bonds through an outside party, leaving the onus on investors to determine if the bond and the issuer align with the investor's standards.

On the other side of the fixed income markets, the banks that underwrite bond sales are benefiting from green bonds. For the first time, J.P. Morgan is making more in fees for underwriting ESG, including green bond sales, than for underwriting fossil fuel related bonds.

Beyond green bonds, in fixed income, managers are now explicitly integrating ESG into their credit analysis process to varying degrees and several have been doing it for many years in various forms. In an asset class with an asymmetric return profile and significant focus on left tail risk, evaluating ESG risk is another layer in the due diligence process and a reasonably natural progression for most fixed income managers. The most common approach is a proprietary or internally generated ESG scorecard or ranking. The scorecard commonly has 20-40 ESG factors that are analyzed and given a score. Those scores typically contribute to a cumulative or average overall score for the bond issuer. The ESG score may be ranked or simply considered in the overall due diligence in the same way that the investment team evaluates management experience, market position, protective covenants in the bond indenture, or other factors along with valuation, fundamental financial metrics, and market technicals. Other managers may draw a harder line in their ESG approach by eliminating a certain amount of the lowest ranking issuers regardless of the strength of their non-ESG factors. A further and more stringent step may be to screen out whole industries such as tobacco, cluster munitions, thermal coal, or companies that are involved in controversial practices such as child labor.

Most fixed income managers now have access to one or more scores from external ESG data providers such as Sustainalytics, MSCI, Bloomberg, ISS, CDP, RepRisk, and RobecoSAM. Meketa has observed that most managers seek to use these third-party scoring providers with their own internal scoring to arrive at a final cumulative score. One approach may be to average them all. Another approach is to determine if the vendors have it wrong such that the manager's internal ESG score is better or worse than what the vendor has ranked the issuer. Finally, the most ESG-advanced managers pursue engagement with corporate issuers which have low ESG scores or are deemed to be ESG laggards. The

[1] Source: https://www.bis.org/publ/qtrpdf/r_qt2009c.htm

engagement process may result in a company making progress and potentially improving a forward-looking ESG score. We note that engagement is more challenging and less commonly practiced by bond managers who are not equity holders with voting rights. Most fixed income managers today utilize the above steps to different degrees. Almost all managers are evolving and improving their ESG approach within the investment process.

We note that some managers have dedicated ESG, Sustainability, or Climate analysts that operate separate from the investment team to arrive at their own conclusions. At some firms with dedicated strategies to ESG, Sustainability, or Climate, the investment team integrates the analysis in a deliberate way. Many firms have these teams but have no dedicated ESG strategy. Another approach is to have dedicated ESG analysts embedded in the investment team to help the fundamental analyst arrive at a holistic view that incorporates ESG factors in the evaluation. Another approach puts the task of ESG analysis on the plate of the same credit analysts doing the fundamental credit work. It is important to understand the approaches to ESG at a manager, the process, the depth of the due diligence, and who is doing the analysis.

In emerging markets debt, a similar process is applied to sovereign issuers where managers score the countries according to another set of ESG factors on a scorecard and arrive at an overall score. They typically then rank the issuers on a relative basis and incorporate this in the overall investment score. Similar to the corporate bond ESG approaches discussed above, there are many degrees of how deeply the manager incorporates the ESG score in the process. Some managers consider the score as one of many factors in the credit analysis while others use it to eliminate countries. Many managers use the score as another factor to consider in deciding how much to underweight or overweight a position vs. the benchmark. Like screening out whole industries, some managers will screen out certain countries based on ESG factors like on low human rights metrics or countries that are subject to sanctions by UN Security Council, for example. A very limited number of EMD managers are involved in ESG engagement. The process for ESG engagement for Corporate and Quasi-sovereign bonds is like the process used in developed market fixed income as described above. Sovereign bond ESG engagement is less common, but a few managers are actively involved. This may come in the form of engaging with countries about key issues like the Sustainable Development Goals ("SDG") or the UN Guiding Principles of Business and Human Rights. These managers may engage with Ministries of Finance, politicians, nonprofit organizations, or other members of their network in a given emerging market country. We note that, ultimately, much of the capital needed to achieve Paris Agreement targets will need to go to emerging markets rather than developed markets. As a result, we believe ESG investing in emerging markets debt will be an increasing area of interest.

Within the context of net-zero investment strategies, differences between emerging markets and developed markets illustrate potential tensions between climate and economic growth issues with net-zero fixed income strategies based on emissions that do not incorporate energy transition metrics. The investment firm, Ninety One provides the example that if an investor halved their allocation to emerging market debt relative to the Barclays Global Aggregate Bond Index, they would decrease portfolio emissions by 11%, using the EU's SFDR measure of emissions relative to GDP for sovereign bonds, with a material reduction in exposure to growth in emerging markets.

Engagement efforts by institutional investors, previously centered on equities, are growing in fixed income, where the regular issuance of debt provides distinct points to discuss with companies their strategies for addressing climate issues.

Hedge Fund Trends

Hedge Funds have generally lagged other asset classes in efforts to integrate sustainable investing into their investment processes, owing primarily to the nature of the underlying investments in hedge funds. Most hedge funds, so-called "macro assets" – index futures, forwards, ETFs, and options – are difficult to analyze from a climate perspective. Hedge funds that focus on "micro-assets" – equity and credit names – can more easily integrate climate themes into their investment strategy.

In terms of hedge fund trends, hedge fund managers are increasingly seeking to integrate climate risk and opportunity in their evaluation of securities. These considerations are not applicable typically to hedge fund managers who invest exclusively through derivative instruments.

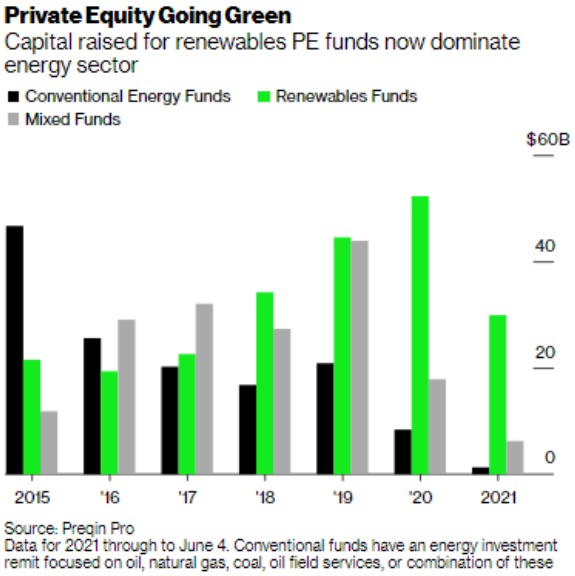
Some climate-related developments are creating opportunities for hedge funds. For example, carbon emissions trading is a form of carbon pricing. It is an approach to limit climate change by creating a market with limited allowances for emissions. Carbon emissions trading started in 1997 when some 180 countries signed the Kyoto Protocol. Carbon emissions trading exists in some fashion in many countries today, including China, the EU, India, and the UK, as well as in states in the US, such as California. As carbon emissions credit trading expands, several firms that offer managed futures funds are trading carbon emissions, most prevalently in Europe. In addition to carbon emissions trading, hedge fund managers are finding investment opportunities in structured products that offer niche exposures, such as reforestation and biodiversity. Managers may take advantage of overlay structures, such as emission-reduction or fossil fuel free, to mitigate carbon exposure in existing portfolios.

Because hedge funds are often designed to take advantage of shorter-term market movements, even hedge funds designed to support investment portfolio decarbonization may potentially conflict with long-term decarbonization of the real economy.

Private Markets

Traditionally, private equity funds ("PE funds") were strong proponents of the fossil-fuel industry. Today, PE funds more often pursue the integration of climate-focused solutions and asset managers are finding strong investment opportunities tied to the climate transition. In 2021, much of the capital raised by private equity energy and infrastructure funds went to PE funds with a renewable focus or component rather than a focus on conventional energy sources, as shown in Figure III.10 below.

Figure III.10 – Private Equity Capital Raised for renewables funds Compared Conventional Energy



Some challenges facing private equity funds in climate-related investments include limited access to data, lack of universally adopted framework (including universal net-zero framework), challenges stemming from internal buy-in, and inconsistent regulatory requirements.[1] Fewer than 10% of all 8,810 private equity firms are currently signatories to the United Nations' Principles for Responsible Investment ("UN PRI"). It can be difficult to determine the exact scope of climate related investments and their performance in private equity.

Private infrastructure, as an investable asset class, appeared around 2005. At that time, common infrastructure investments were gas-fired power plants, midstream pipelines, and transportation. By 2021, 80% of the infrastructure energy funds (not assets) that closed invested in renewable energy, in contrast to 6% in non-renewable energy funds and 14% in mixed.[2]

Real estate is susceptible to climate change risks as a physical long-term asset. Rising seas, extreme weather, and water availability will all have economic impacts. Regarding emissions, real estate development represents 30% of GHG emissions worldwide.[3]

In real estate private markets, trends relating to climate change investing appear mixed. The underlying real estate assets – the buildings – are where many energy efficiencies are incorporated. It is becoming common for new builds to include motion sensors, low flow water, green roofs, and water harvesting, among the many other wide and various energy efficient options. For existing properties, real estate managers analyze the amount of investment needed to add or gain more energy efficiency.

[1] James, K., &; Lubber, M. (2021). (rep.). The Changing Climate for Private Equity. Retrieved October 2021, from https://www.ceres.org/resources/reports/changing-climate-private-equity.

[2] Jacobius, A. (2021, September 20). Changing Energy Landscape Fuels Infrastructure Investing. Pensions & Investments. Retrieved October 18, 2021, from https://www.pionline.com/alternatives/changing-energy-landscape-fuels-infrastructure-investing

[3] International Energy Agency: https://www.iea.org/topics/buildings

Meketa currently is aware of one real estate manager that markets real estate funds that are aware of physical climate risks. Otherwise, there are a handful of managers that have strong ESG programs within the broader company that spill into better green/climate aware management at the real estate fund level. Industry data shows that investment managers have created relatively few green real estate funds. However, data is not readily available to show market-wide inflows or demand for green real estate products or to clearly demonstrate climate change trends within private market real estate investment.

IV. Policies, Regulations, and Institutional Collaboration

Policy and Regulatory trends show accelerating shifts in climate regulations and policies. The sheer volume of change affects investment markets. Institutional collaboration around climate continues to expand to encompass engagement with companies (through both equities and fixed income investments) and engagement with governments. **By far, the policy decisions of legislative and regulatory bodies will dwarf the direct impact of institutional investors**.

Over the last several decades, world leaders have debated how to combat climate change. These discussions produced several important pacts, including the Kyoto Protocol and, most recently, the Paris Agreement. Through these treaties, countries agree to reduce GHG emissions to address climate change. Although governments generally agree on the science behind climate change, they have differing views on who is most responsible and how to set emissions-reduction goals. A central issue is that developed countries historically produced the most emissions as they developed their economies, while emerging markets bear much of the brunt of the climate risks from these historic emissions and will require a different time path to reduce emissions than for countries that are already developed.

Although negotiations largely began with world leaders at the national level, climate change policies are being enacted at state and local levels as well. Three notable examples in the US are New York, Minnesota, and California. New York's Climate Act is among the most ambitious laws in the world. This Act requires New York to reduce GHG emissions 40% by 2030 and 85% by 2050 from 1990 levels, along with a list of other requirements intended to place New York on a path toward carbon neutrality.[1]

In Minnesota, the state rolled out a multi-agency initiative called Minnesota Climate, which focuses on reducing Minnesota's GHG emissions by 80% by 2050.[2] The set of policy proposals will lead Minnesota to 100% clean energy in the state's electricity sector by 2050. The policies build on Minnesota's past reductions of fossil fuels and aim to increase the use of clean energy resources while ensuring reliable, affordable electricity. Xcel Energy, Minnesota's largest utility, has publicly committed to generating 100% of its electricity from clean energy by 2050. The proposal focuses on three key areas: 100% clean energy by 2050, clean energy first, and energy optimization. In 2016, the transportation sector surpassed electricity as the sector generating the largest CO_2 emissions in Minnesota. Among many other statewide initiatives, Governor Walz asked the Minnesota Pollution Control Agency ("MPCA") to start the rulemaking process by adopting two emissions standards that will reduce GHG emissions from passenger vehicles: the Low-Emission Vehicle ("LEV") standard and the Zero-Emission Vehicle ("ZEV") standard. Other initiatives include support for development of a statewide electric vehicle charging network, support for climate transition in agriculture and biofuels, and support for homes to reduce energy use.

California has long been a leader of climate change policies and initiatives in the US. As such, in 2006 the state passed aggressive legislation (the California Global Warming Solutions Act of 2006) to reduce its overall GHG emissions to 1990 levels by 2020 and 40% below 1990 levels by 2030, and it appointed the California Air Resources Board ("CARB") to develop the necessary policies to achieve this goal.[3] This

[1] Source: Climate Act. Retrieved from https://climate.ny.gov/

[2] Source: Our Minnesota Climate. Retrieved from https://climate.state.mn.us/.

[3] Source: California Air Resources Board AB 32 Global Warming Solutions Act of 2006. Retrieved from https://ww2.arb.ca.gov/resources/fact-sheets/ab-32-global-warming-solutions-act-2006.

legislation was the first of its kind in the country to take a comprehensive, long-term approach to addressing climate change. The goal was to place California on a path to a low-carbon future.

This section highlights trends in climate change policies globally, first by documenting the current climate change agreement in place, the Paris Agreement. The charts indicate how nations have implemented climate policies and outlines the goals and pledges during discussions at the 26th UN Climate Change Conference of the Parties ("COP26") in November 2021.

The Paris Agreement, often referred to as the Paris Accords or the Paris Climate Accords is a legally binding international treaty on climate change that was signed by 195 nations at the COP21 in Paris in December 2015. This agreement mandated climate change policy at the international level and covers climate change mitigation, adaptation, and finance. It was groundbreaking at its inception because for the first time developed and emerging countries committed to work together to tackle the climate change crisis. The goal of the Paris climate accord was to create a climate-neutral world by 2050. Although most nations signed the Paris Agreement, experts say the pledges are not ambitious enough to prevent global temperatures from warming more than 1.5°C above pre-industrial times. It is expected to be extremely challenging for nations to shift their economies sufficiently to meet their pledges.

Becoming "climate neutral" means reducing GHG emissions as much as possible but also compensating for any remaining emissions by removing carbon dioxide and other GHGs from the atmosphere, using natural or artificial processes. To achieve this goal, each signatory pledged to reduce their respective GHG emissions to keep global temperatures "well below" 2.0°C above pre-industrial times and attempt to limit them even further to 1.5°C. The long-term temperature goal of 1.5°C is important as climate scientists explain that a rise in global temperatures above 1.5°C can lead to more frequent and severe natural disasters, resulting in catastrophic damage. The average global temperature has already risen by about 1°C. Therefore, scientists say that world leaders must take more aggressive action to effectively mitigate climate change. World leaders gathered at COP26 to try to agree upon next steps.

Climate change policies vary amongst countries largely because developing countries are much more dependent on fossil fuels as a core component of their economic growth. In April 2021, President Biden hosted a virtual summit with 40 world leaders called the Leaders Summit on Climate, with the goal to rally the world in tackling the climate crisis. At the summit, the US and several other countries announced ambitious new climate targets aimed at cutting GHG emissions to limit global warming to 1.5°C above pre-industrial levels. In addition, world leaders reiterated the need to use nature-based solutions to fight climate change and discussed how achieving net-zero by 2050 is not possible without natural climate solutions, such as preventing illegal deforestation and the loss of wetlands and restoring marine and terrestrial ecosystems.

During the summit, the US pledged to cut carbon emissions by 50-52% below 2005 levels by the year 2030, which essentially doubles the previous promise. In addition, the US announced its support of a proposal to protect the Southern Ocean through the three marine protected area proposals under the Convention for the Conservation of Antarctic Marine Living Resources ("CCAMLR"). All participants highlighted their support for protecting and conserving land and marine areas to eliminate carbon and build climate resilience.

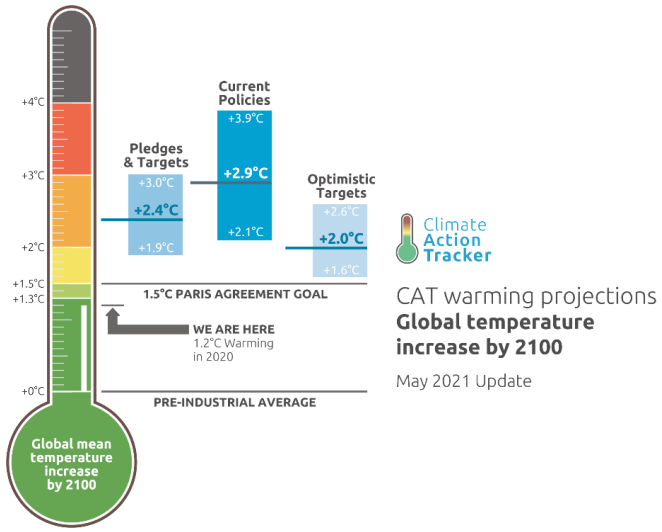
Canada, the EU, the UK, and Japan pledged to cut GHG emissions more aggressively. Canada promised to limit emissions by 40-45% by 2030, which was an increase from its prior commitment to a 30% reduction. Canada is also allocating $4 billion of its new federal budget to land and ocean protection

efforts. The EU announced its plans to cut emissions by at least 55% by 2030, compared with 1990 levels. This goal is a substantial step up from the EU's previous 2030 target of cutting emissions by 40%. The UK government said it wanted to cut carbon emissions by 78% by 2035, which is 15 years earlier than its current target. Japan pledged to reduce emissions by 46% in 2030 compared to 2013 levels. Previously, the country had pledged only a 26% cut in emissions. China made no new pledges at the virtual summit. The Chinese government noted that they would tackle coal in the next few years as the President of China plans to regulate coal projects and coal consumption more severely. Brazil committed to achieve net-zero by 2050, end illegal deforestation by 2030, and double funding for deforestation enforcement. Although these commitments are positive, scientists are urging more aggressive and immediate action from world leaders, especially after COP26.

COP26 in Glasgow was the biggest climate change conference since the Paris Agreement. More than 100 world leaders and thousands of diplomats from nearly 200 countries gathered to negotiate ways to cut GHG emissions by 2030. By the end of COP26, 151 countries had submitted new climate plans (known as nationally determined contributions, or NDCs) to slash their emissions by 2030. To keep the goal of 1.5°C within reach, it is estimated that we need to cut global emissions in half by the end of this decade. In contrast, the UN calculates that these plans, as they stand, put the world on track for 2.5°C of warming by the end of the century. The Glasgow decision calls on countries to "revisit and strengthen" their 2030 targets by the end of 2022 to align them with the Paris Agreement's temperature goals. It also asks all countries that have not yet done so to submit long-term strategies to 2050, aiming for a transition to net-zero emissions around mid-century. In addition, the pact asks nations to consider further actions to curb potent non-CO_2 gases, such as methane, and includes language emphasizing the need to "phase down unabated coal" and "phase-out fossil fuel subsidies." This marked the first time that negotiators have explicitly referenced shifting away from coal and phasing out fossil fuel subsidies in COP decision text. COP26 recognized the importance of nature for both reducing emissions and building resilience to the impacts of climate change, both in the formal text and also through multiple initiatives announced on the sidelines.

Figure IV.1 illustrates an estimate of the current climate pledges and targets in relation to their estimated ability to address global warming. As shown, current pledges and targets, policies, and even optimistic targets, together fall short limiting the global temperature rise to 1.5°C.

Figure IV.1 – Climate Pledges, Targets, and Current Policies[1]



Carbon reduction targets by countries continue to climb. To date, 49 countries plus the EU pledged a net-zero target. This includes 12 G20 countries. The pledges cover over half of global domestic GHG emissions, over half of GDP and a third of the global population. Eleven targets are enshrined in law, covering 12% of global emissions. If made robust and implemented fully, net-zero targets could help bring the predicted temperature rise down to 2.2°C. However, many of the national climate plans delay action until after 2030, raising doubts over whether governments can deliver net-zero pledges.

For financial markets, the rapid growth in climate and more broadly ESG investing with a lack of regulation and standards, has generated risks of greenwashing and makes it more difficult for investors and companies to analyze and make strategic decisions to address climate transition issues.

Regulation and standardization are starting to develop globally. To date, there is a lack of global baseline standards on climate reporting. The lack of standardization increases the range of reporting required by companies and asset managers and reduces the clarity for asset owners into investment products and underlying data on investee companies.

Europe has led the way in regulations surrounding so-called "green" investments. The EU's Non-Financial Reporting Directive ("NFDR") allowed investors to review such disclosures since 2018. The EU's Sustainable Finance Disclosure Regulations ("SFDR") and EU Taxonomy regulation provides a framework to overcome some of the shortcomings in consistency and reporting. The EU Taxonomy Delegated Act sets out a list of environmentally sustainable economic activities that make a significant contribution to climate change mitigation and adaptation, providing investors and issuers a common language as it pertains to climate friendly investing. The Taxonomy Regulation will roll out additional legal disclosure obligations for issuers claiming the "green" label in 2022.

In the US, both the SEC and the Department of Labor ("DOL") proposed regulatory changes that address ESG including climate issues in 2021. In March 2021, the SEC created a new Climate and ESG Task Force to identify misconduct related to climate and ESG issues in investing. They requested

[1] Source: Climate Action Tracker.

comment specifically on how the SEC should regulate climate change disclosures and broader ESG disclosure. In September 2021, the SEC proposed new disclosure rules to enhance the information mutual funds, ETFs, and certain other funds report annually about their proxy votes and make that information easier to analyze. In October 2021, the DOL proposed new rules that would explicitly direct ERISA pension plan fiduciaries to consider that ESG issues could present material business risks or opportunities to companies and create a new presumption that a prudent fiduciary should consider ESG issues when evaluating the risk and return profiles of investment opportunities. This new language clarifies and confirms explicitly that climate change and other ESG factors are no different from other "traditional" material risk-return factors, and that plans should regard these factors on an equal footing in the investment decision-making process.

A landmark announcement on November 3, 2021, accelerates efforts to create international standards, convergence among regional standards, and convergence among the multiple existing voluntary standards. The newly launched International Sustainability Standards Board ("ISSB"), by the International Financial Reporting Standards Foundation ("IFRS") will absorb corporate reporting bodies Climate Disclosure Standards Board ("CDSB") and the Value Reporting Framework ("VRF"). The ISSB will sit alongside and work in close cooperation with the International Accounting Standards Board ("IASB"). The lack of consistent standards has created uncertainty and raises investment risk and reduces the clarity for asset owners into investment products and underlying investee companies. Such convergence, as is evident in the IFRS announcement, can help fulfill the demand for streamlining and formalizing corporate sustainability disclosures and improving transparency for investors. The IASB recently took nearer-term governmental accounting steps to clarify existing reporting standards which make explicit that IFRS financial reporting must incorporate material climate risks.

Collaborative efforts to address climate change continue to expand throughout financial and economic markets. Many organizations have coalesced under the Race to Zero umbrella. Each of the Race to Zero members are committed to the same overarching goal: reducing emissions across all scopes, swiftly and fairly in line with the Paris Agreement, with transparent action plans and robust near-term targets. Together they form the largest, growing alliance of non-state actors committed to taking rigorous and immediate action to halve global emissions by 2030 and deliver a healthier, fairer zero carbon world in time.

Collaborative efforts are providing tools that asset owners and managers can utilize to set interim milestones and targets to apply to both investment and engagement processes. These include the Net Zero Asset Owners Association, the Net Zero Asset Managers Initiative, the UN convened Net Zero Asset Owner Alliance and the Target Setting Protocol, the Science Based Targets initiative for financial institutions, the Paris Aligned Investment Initiative, and the Net Zero Investment Framework 1.0.

V. Climate Data, Metrics, and Ratings

Data availability is an essential element of investment analysis. Trends in the evolution of climate data indicate that over time we can expect:

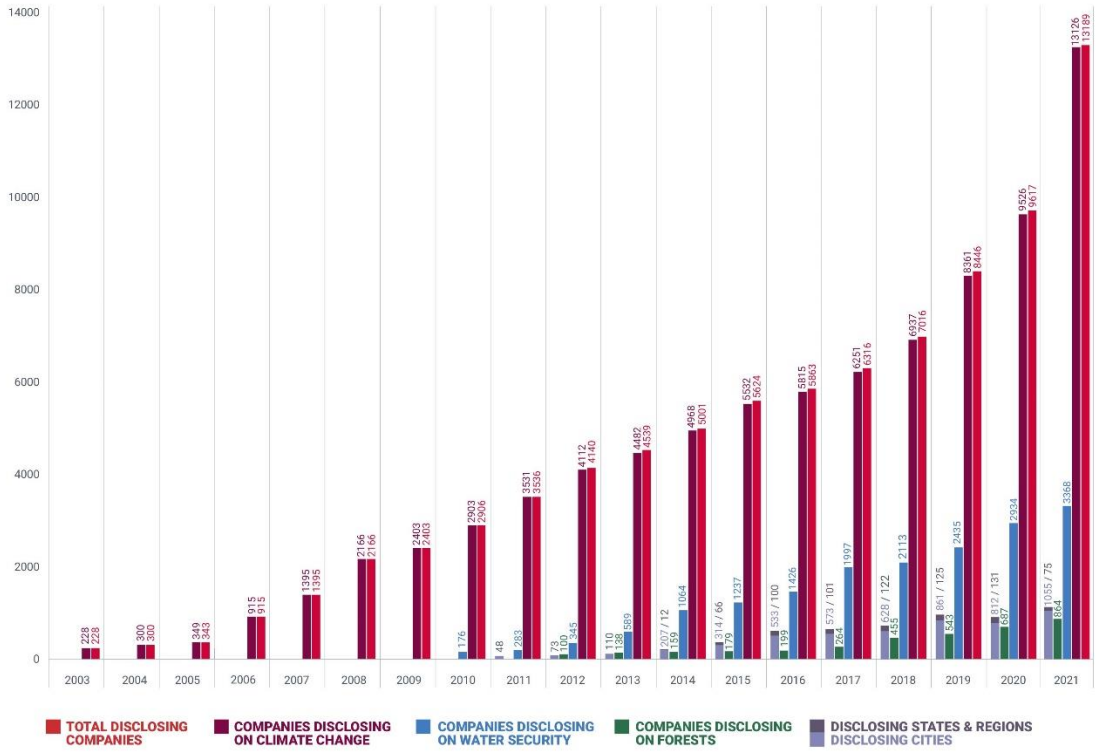
- Improvements in the quality and quantity of climate data.
- Coverage of more companies, including privately held companies, and more asset classes.
- Refinements to existing measures, and development of new metrics, including more forward-looking transition metrics that potentially enhance our ability to analyze the climate risks that investors face, and greater development and attention to all scopes of emissions, including Scope 3.
- Data and metric standardization can benefit from evolving regulatory standards and over time better harmonization of standards across jurisdictions.
- Greater transparency on environmental and ESG ratings, and potential increased correlations among rating providers as standards develop.

Lack of Data

Climate data is unavailable for many key climate risk metrics and is thus modeled or estimated by data providers. Increasingly, company data, particularly for larger companies, is being made available consistent with voluntary standards developed by private and non-profit organizations. For example, the number of companies disclosing on climate change data to the CDP grew from 228 companies in 2003, to nearly 4,500 a decade later, reaching over 9,500 by 2020 and ramping to more than 13,000 in 2021. The 13,126 CDP reporting companies in 2021 represent more than 64% of global market capitalization. CDP reporting today includes more than 14,000 entities when the count includes the hundreds of cities, states and regions that disclosed to the CDP in 2021.[1]

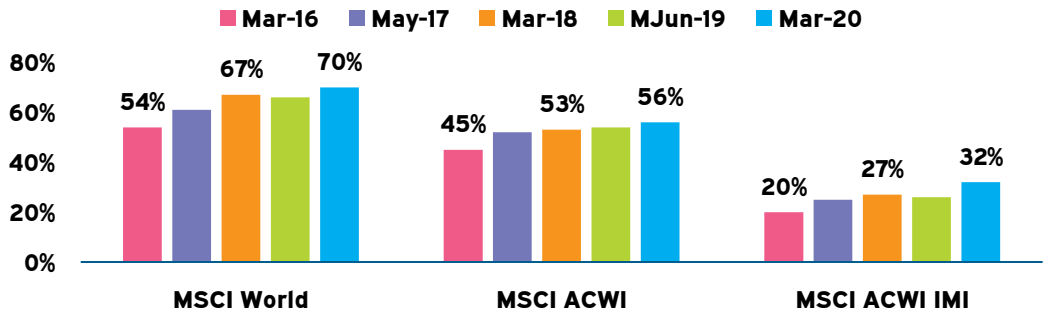
[1] CDP, "Accelerating the Rate of Change; CDP Strategy 2021-2025, October 2021.

Figure V.1 – CDP Reporting Growth[1]



The percent of publicly listed companies that disclose Scope 1 and 2 carbon emissions data has grown globally and across all markets, with the greatest coverage among larger companies, and developed markets, as illustrated in Figure V.2 in the increase in disclosures for the MSCI World, MSCI ACWI, and MSCI ACWI IMI indexes.

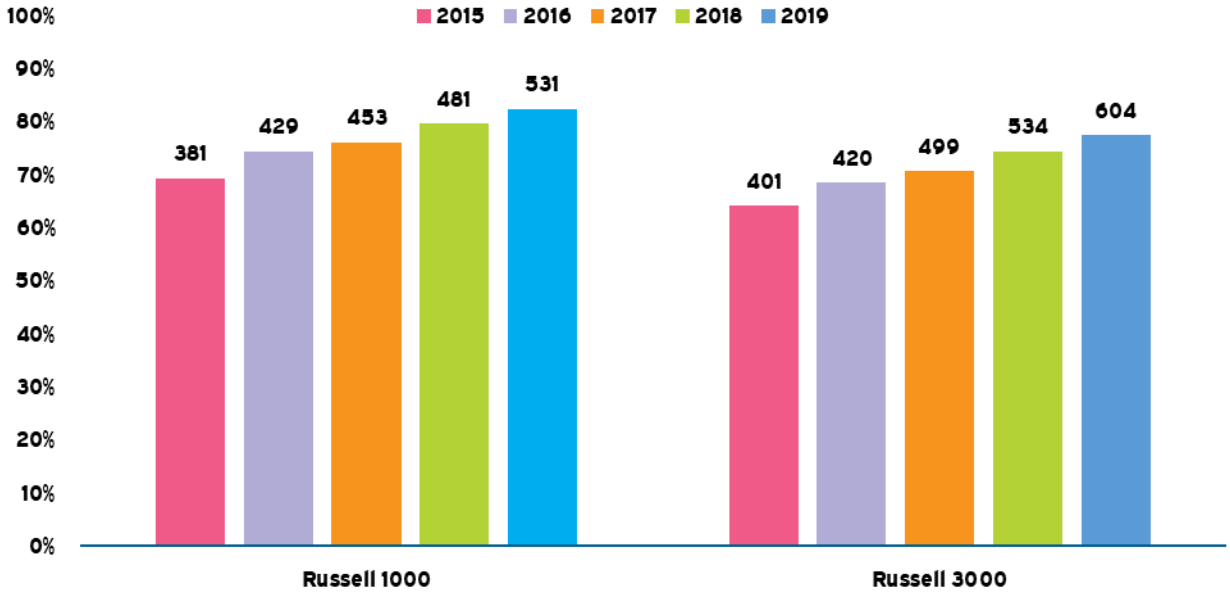
Figure V.2: Percentage of MSCI Index Companies with Disclosed Scope 1 + 2 Carbon Data by Universe[2]



[1] Source: CDP.

[2] Source: MSCI.

Figure V.3: Russell 1000 and 3000 Scope 1 and 2 carbon emissions disclosure data (Percent of index), number of companies that report



As shown in Figure V.3, in the US, the same patterns hold, where larger companies tend to report emissions data more than smaller cap companies. For example, in 2019, the latest data for which FTSE/Russell had carbon reporting data available, 531 of the Russell 1000 companies reported Scope 1 and 2 emissions which accounted for 82% of the index. For the Russell 3000 index, 604 of the total 2,992 companies reported emissions in 2019 which accounted for 77% of the index.

With 59% of the US domiciled companies that are constituents of the MSCI ACWI disclosing Scope 1 and 2 Carbon emissions data, the US lags its European counterparts, Japan, and some developing countries in the percent of companies disclosing carbon emissions data, as show in Figure V.4. China lags much further, at 21% of MSCI ACWI China domiciled companies reporting on carbon emissions.

Figure V.4: Percentage of MSCI ACWI Companies with Disclosed Scope 1 + 2 Carbon Data, by Country of Domicile[1]

[1] Source: MSCI.

Along with raw data, the number of entities with published climate metrics continues to grow. For example, in October 2021, the Transition Pathway Initiative ("TPI"), an asset owner led initiative, which assesses companies' preparedness for the transition to a low carbon economy, announced the 2022 opening of the Global Climate Transition Centre. The Centre has the backing of asset owners and managers with combined assets under management or advisement of $40 trillion. Through the Centre, the TPI plans to assess 10,000 issuers, up from 400-plus today, on their alignment with a net-zero pathway, and expand coverage from equities to encompass bonds. TPI divides company assessments into two parts: The TPI "Management Quality" covers companies' management/governance of GHG emissions and the risks and opportunities arising from the low-carbon transition. The TPI "Carbon Performance Assessment" involves quantitative benchmarking of companies' emissions pathways against the international targets and national pledges made as part of the 2015 Paris Agreement, for example limiting global warming to below 2°C. TPI bases both assessments on company disclosures.

Asset Class Coverage Primarily of Public Equities

ESG and climate data and ratings first emerged for public equities. Fixed income and private markets ESG and climate-specific data are now coming to market. For example, the CDP plans to expand its climate disclosures to debt, sovereign, and private markets, and has launched pilots for private equity and venture capital.[1]

In September 2021, global credit rating provider, Fitch, announced the creation of a comprehensive range of ESG ratings products with transparency to underlying rationales, at both an entity level and instrument level for the investable fixed income market. Fitch implemented its ESG Relevance Scores in 2019. These scores quantify the effect that ESG factors have on current credit ratings of entities and debt instruments. For these scores, the forecast is rarely out further than a standard assessment period of three to five years.

The Fitch ESG Vulnerability Scores measure the relative vulnerability of sectors and entities to long-term ESG-related changes under a scenario that incorporates a global transition to a 2°C warmer climate by 2050. The analysis extends to 2050 and provides milestone assessments from 2025. Fitch's ESG Vulnerability Scores' core stress scenario is the UN PRI Inevitable Policy Response ("IPR") Forecasted Policy Scenario ("FPS"). As Fitch summarized: "The scores are a ranking of the relative risks to sectors and entities based on what we believe could (rather than will) threaten them. Our view is based on credible downside risks drawn from current scientific understanding, policy discussion and commitments, and technological achievements."[2]

The GRESB Real Estate Assessment is the investor driven global ESG benchmark and reporting framework for listed property companies, private property funds, developers and investors that invest directly in real estate. The GRESB Real Estate Assessment requires that funds report on their energy, waste, and water data as well as their Scope 1, 2, and 3 GHG emissions within the Performance Indicators Aspect, which is worth a quarter of the overall GRESB score. The GRESB Assessment introduced mandatory reporting of Scope 3 emissions in 2018 following pressure from investors to capture a more comprehensive view of emissions portfolios.

Physical climate risk is central to real estate risks. Start-ups are creating technologies that measures the risks posed to real estate. One such company is Four Twenty Seven Inc. (majority owned by

[1] CDP, "Accelerating the Rate of Change; CDP Strategy 2021-2025, October 2021.

[2] Fitch Ratings, Special Report, 15 January 2021, p.4.

Moody's), which maps climate data of real estate properties against climate risks and gives each property a score.

Private market databases on climate metrics are developing. They are likely to be generally constrained by the private nature of the issuers. In September 2021, CalPERS and Carlyle Group led a group of global private equity firms and pensions funds managing over $4 trillion in assets that have agreed to standardize reporting on (ESG) performance of portfolio companies, tracking data on GHG emissions, renewable energy, board diversity and other metrics. Additional efforts to address the lack of private market climate data are emerging. For example, on October 7, 2021, the Ford Foundation, S&P Global (NYSE: SPGI), Hamilton Lane (NASDAQ: HLNE) and Omidyar Network, launched Novata as an independent, unbiased and flexible open architecture platform for private markets to more consistently report on relevant ESG data. ESG data providers are expanding to private market climate data. For example, in October 2021, MSCI and The Burgiss Group announced a new carbon footprint toolkit that includes measuring and monitoring GHG emissions of private equity and debt portfolios, based on estimates for over 15,000 companies in more than 4,000 active private equity and debt funds, and measure progress towards net-zero commitments.

Improvements to climate metrics and development of new metrics

Metrics to capture physical climate risk and energy transition risk are rapidly evolving. Many data providers and organizations are contributing. Early on, climate risk metrics investors often centered on a company's carbon footprint, or the Scope 1 and Scope 2 carbon emissions embedded in the asset owner's investment. Concerns over potential stranded assets, particularly of fossil fuel reserve owners, prompted the development of metrics to measure potential stranded assets for fossil fuel reserve owners.

With the adoption of Task Force on Climate Related Financial Disclosure ("TCFD") framework for climate reporting, carbon intensity, measured as Scope 1 and 2 emissions per $1 million revenues became a leading economy-wide metric. In parallel, efforts to better understand company's management of climate risks led to the development of forward-looking and corporate strategy metrics, such as alignment with a net-zero long-term trajectory, use of science-based emissions reductions targets, and whether companies establish interim targets to supplement long-term targets.

Recognition of the critical differences in which sustainability issues are financially material for different industries spurred integration of industry-based distinctions, such as those based on the Sustainable Accounting Standards Board ("SASB"). Recently, data and metrics improvements have included measurement and coverage of Scope 3 emissions. Scope 3 emissions vary widely across industries and sub-industries, and for some industries Scope 3 emissions are a large percent of total emissions. For example, using ISS emissions data, adding Scope 3 emissions increased total emissions for energy sector companies by an estimated 887%; 269% for the industrials sector companies; 137% for the materials sector; and 135% for the utilities sector.

The TPI brings a clear focus on transition that is industry specific, including metrics on how the transition is managed, along with trends in emissions relative to transition goals such as alignment with the Paris Accord.

New climate metrics are emerging. For example, Ninety One proposes new transition metrics for sovereign debt to provide better measures of the how countries are transitioning to net-zero. They raise the question of measuring emissions based on where a product is consumed, rather than

production based, which would significantly change the accounting for many products that are produced in emerging markets but consumed in developed markets, from phones to solar panels.

As another example of a forward-looking metric, Carbon Tracker Advisor, Greg Rogers, created a new, simple open-source metric entitled Carbon Quotient ("CQ") to measure forward exposure to emissions using data such as property plant and equipment – and across the economy, not just the fossil fuel supply sector. The data required is basic financial data, so public and private companies will have the data. The metrics build on audited financials to adjust the income statement and balance sheet to reflect a particular 'what if' scenario – 'what if' this company or this portfolio had to be carbon neutral today as a matter of law? Would it be profitable? Would it be solvent? Climate-related financial risk and opportunity both arise from the need to retire and replace carbon-intensive assets with low or zero carbon alternatives on an expedited schedule. By treating everyone the same, assuming net-zero applies to everyone *today* by law, CQ analytics allow investors and corporate managers to compare different investment options on an apples-to-apples basis in a way that reflects financial risk.

The CQ ratio differs from carbon intensity in two ways: First, by accounting for future unrealized emissions embedded in existing long-lived assets, the CQ ratio is forward-looking. Second, by correlating unrealized emissions with the assets that produce them, which assets risk becoming stranded, the CQ ratio serves as a measure of financial risk.

Lack of Regulatory Standards

The rapid private sector development of financial ESG products and data has occurred without clear regulatory standards. Market-led voluntary framework leaders are actively working to bring more consistency across frameworks, as can be seen in the merger between SASB and the IRRC into the Value Reporting Foundation, and incorporation of various efforts such as TPI and SASB into alignment with the TCFD framework. Where government standards are developing, they are inconsistent across geographic regions. Trends indicate that regulations that seek to standardize the taxonomy for data presentation and for marketing investment products as ESG or Climate/Sustainable will continue to grow, likely led by the EU and the UK, with standards in the US and other jurisdictions also emerging. In 2021, the SEC took steps to review current climate disclosure regulations to potentially require additional disclosures. The SEC also announced in 2021 that its examination priorities would shift to include a greater focus on climate-related risks. The November 2021 announcement by the IFCR on the launch of the ISSB, and absorption of the VRF noted above, marks a significant step forward in convergence of international standards for climate and other sustainability reporting.

Opaque Ratings and Low Correlation on Ratings Among Key Raters

With the rise of climate data and metrics, data providers are providing overall ESG ratings and ratings for each pillar – Environmental, Social, and Governance. The intent of the ratings is to provide greater understanding of the differences between companies on ESG issues, including climate issues. The opaque nature of the ratings and the divergence of ratings across different providers makes such ratings more difficult for investors to use.

Multiple studies have found relatively low levels of correlation on ESG scores among different providers. They also find low correlations between ratings on the Environmental dimension. For example, findings of Berg, Koebel and Rigobon, MIT Sloan and University of Zurich in "Aggregate Confusion: The Divergence of ESG Ratings", December 29, 2020, found Correlations between ESG ratings of six providers were on average 0.54, and range from 0.38 to 0.71. The correlations of the environmental

dimension were slightly lower than the overall correlations, with an average of 0.53, and a range from 0.23-0.73. These results were largely consistent with prior findings by Chatterji et al. (2016), and with findings from Christensen, Serafeim and Sikochi (2020).

While disclosure of ESG data is increasing, Christensen, et al (2021) finds that greater disclosure currently leads to greater disagreement among ratings, driven primarily by environmental and social disclosures. Berg et al (2020) investigate reasons for the divergence among ESG ratings and find that the main driver of the divergence is measurement (ratings are based on different measurements of the same attribute), while scope (the types of attributes included) and weights (ratings are based on different views of the relative importance of attributes) are less important.

Low correlations among ESG ratings likely reflect at least in part the early stages of institutional innovation around ESG disclosure and metrics, and their development prior to regulators stipulating any standard taxonomy with which to organize and provide data. Over time, as consistent standards for environmental and broader ESG disclosure emerge, and as data and measurement approaches become more transparent, ratings divergence may slowly be reduced. Measurement divergence may be reduced through clearer taxonomy and disclosure.

VI. Climate Scenario Analysis

Climate data, metrics, and ratings focus on assessing individual companies on their climate risk profiles and progress. Portfolio-wide analysis is also emerging. Climate scenario analysis related to climate modeling is an actively evolving area of both discussion and practice among different types of economic actors – asset owners, investment managers, and corporate leadership, among others. In some respects, climate modeling resembles other forecasting tools routinely used by institutional investors (e.g., mean-variance forecasting, portfolio stress tests, and historical scenario analysis) that require significant judgment regarding assumptions and invariably err to some degree versus reality but are nonetheless useful when planning portfolio positioning. Scenario frameworks can help provide a means of evaluating the impact of various climate-related proposals and potentially aid comparability of impacts across different groups of stakeholders. Forward-looking scenario analysis, when combined with assessment of the current climate positioning of a portfolio, makes it possible to understand the costs of various climate objectives more fully for a portfolio and determine a plan to attain those goals and preexisting financial goals. We review the current state of some modeling frameworks, discuss different types of scenario models, and their benefits and drawbacks.

Modeling Frameworks

Although initially mentioned in many codifications of climate frameworks in the middle of the 2010s, in the last several years there has been greater attention paid to financial climate modeling, including objectives and approaches. These features tend to vary based on the sponsoring entity and their position within the financial system.

Task Force of Climate Related Financial Disclosures ("TCFD") The TCFD, a task force established by the Financial Stability Board, develops recommendations for more effective climate-related disclosures to enable better investment, credit, and insurance underwriting decisions while simultaneously aiding transparency of carbon-related assets in the financial system. TCFD's recommendations are not targeted directly at asset owners, instead encouraging other organizations to use scenario analysis to identify and assess the potential implications of a range of plausible future states under conditions of uncertainty and to make that information available to inform the decision making of investors and stakeholders. The TCFD approach to climate scenario analysis is flexible, acknowledging that quantitative, as well as written qualitative assessments, can be helpful for assessing risks across a number of areas including transition risk, physical risk, policy & legal risk, and reputational risk. They emphasize that to be most useful, organizations should consider multiple scenarios that cover a reasonable variety of future outcomes, at least one of which is aligned with a 2°C scenario. Other helpful scenarios may include scenarios informed or mandated by national actors or physical and transition risks that are particularly suited to the organization's operations. More recent communications have provided clarifying details about TCFD's 2017 positions on scenario analysis, provided case studies for use, and solicited additional commentary integrating climate into risk management processes and determining useful financial sector metrics.

Although TCFD's framework is targeted at organizations and may more naturally function as input into asset owners' analyses of climate issues, their considerations for assessing design decisions in scenario analysis are also applicable in a portfolio context:

- Consideration of which parameters to use, the degree of certainty associated with those parameters, and sensitivity of output to changes in parameters.
- Assumptions made regarding policy changes, technology development/deployment, energy mix, price of key commodities or inputs, geographical tailoring of transitional and physical impacts.
- Evaluation of analytical choices including selection of scenarios, time horizons evaluated, and selection of supporting data and models.

In addition to its work on scenario analysis, the TCFD also advocates for increased financial transparency regarding climate exposures, information which can integrated into multiple types of scenario frameworks.

Network of Central Banks and Supervisors for Greening the Financial System ("NGFS") NGFS is a group of central banks and financial regulatory supervisors collaborating to contribute to the development of environmental and climate risk in the financial sector and sharing of best practices among the group. Given the economy-spanning responsibilities of its member institutions, the NGFS scenario framework focuses on macroeconomic impacts across a number of scenarios and their impact on the global financial system and the wider global economy. Recognizing the difficulty of determining detailed, plausible scenarios given the inherent uncertainty of climate modeling, NGFS has focused its efforts on developing and providing background data on six scenarios spanning a number of emissions/temperature scenarios and a spectrum of policy responses ranging from organized to disorganized. These scenarios are periodically updated to reflect shifts in climate policy, changes in IMF growth projections, and impacts from disruptive events (e.g., COVID-19). These particular scenarios not only cover a broad range of possible scenarios, but also demonstrate varying levels of exposure to physical and transition risks, exposures which tend to be inversely correlated (i.e., transition steps taken will tend to increase transition risks for economic actors but simultaneously decrease physical warming and its attendant risks) though they do interact to some degree in portions of the model ensemble.

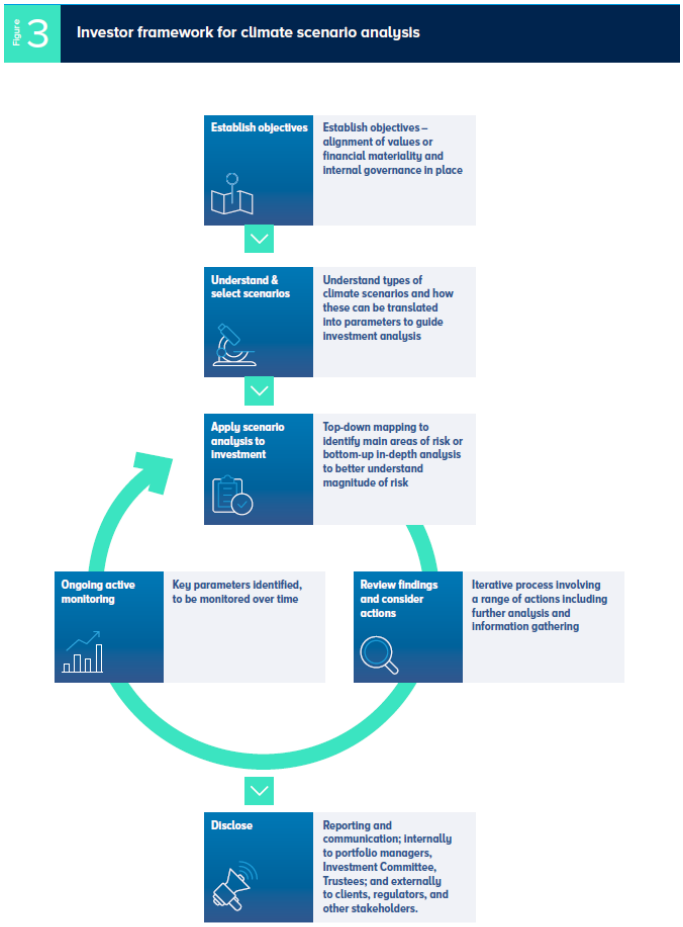
LT Climate Policy	ST Climate Policy	Policy Coordination	Sequestration Availability
Below 2.0°	Immediate	High	Medium
Net Zero	Delayed	Medium	Low
Natl. Determ. Contributions		Low	
Current			

While the NGFS approach lacks some flexibility due to its use of pre-determined scenarios, the scenarios are based on an ensemble of models and provide well specified data, both in terms of outputs as well as documented linkages throughout. Its assessments of aspects of physical and transmission risk are broadly defined and provides high-level data suitable for reviewing portfolio risk exposures in a top-down manner.

Institutional Investors Group on Climate Change ("IIGCC") The IIGCC is a group formed to foster investor collaboration on climate change and is primarily composed of European asset owners and investment managers. They seek to support and help define the public policies, investment practices, and corporate behaviors that will result in progress towards a net-zero climate goal by 2030. While generally aligned with the TCFD, the IIGCC recognizes that climate scenario analysis presents unique challenges to

financial and investment practitioners: climate impacts have both great breadth and magnitude, highly uncertain and long-time horizons, foreseeable wide scale outcomes but little detailed certainties, and long-term consequences that are impacted by short-term actions. The framework also recognizes that asset owners may seek to use scenarios to assess both financial (e.g., liability/solvency impacts, investment selection) and climate outcomes (e.g., net-zero alignment, stakeholder engagement) simultaneously. Given the different starting point and different needs of various investors, the IIGCC discusses a variety of approaches to formulating and using scenario analysis, noting that simplified scenario approaches can be appropriate to have a better initial understanding of the impact of certain policies but also provides perspective on the use and selection of more sophisticated integrated modelling techniques. The IIGCC also specifically addresses the issue of translating the output of climate models into relevant financial metrics. Their approach allows for both top-down analyses that focus on macroeconomic implications of climate change and their impacts on strategic asset allocation and liabilities, and bottom-up analyses that model impacts at the asset, sector, and portfolio levels which can be aggregated in a holistic analysis of the whole portfolio.

Figure VI.1 – Spectrum of Approaches: Top-Down versus Bottom-Up[1]



[1] Source: IIGCC.

As shown in Figure VI.1, there are a spectrum of approaches to climate scenario analysis. Climate scenario methods generally fall into "top-down" or "bottom-up" categories. Multitudes of options exist within those categories and there is considerable scope for combined or aggregated models.

Bottom-up models generally take detailed information about individual companies and industries, then analysts apply and aggregate the information across an entire portfolio. Starting with the outputs of climate models, investors determine what linkages between climate variables and traditional financial valuation and risk variables seem plausible. These linkages can integrate climate considerations into traditional investment processes to provide climate-aware insights. The ability to integrate into existing approaches is a key benefit of a bottom-up approach. As transparency and disclosure requirements like those advocated by the TCFD become more mainstream, the ability to adjust individual asset and sector models to account for climate variable should improve.

While these methods are very granular, they provide insight into current practices and exposures and can yield results that do not necessarily translate to long-term strategic decision making. While climate models can provide long-term forecasts of environmental and associated variables, the linkages between this data and financial variable, as well as asset-level and sector-specific models, are not necessarily built to forecast future values over long time-periods. Additionally, aggregation can reduce the usefulness of the analysis (e.g., a bottom-up analysis that forecast shifts within asset classes but little change in returns among asset classes would have limited usefulness for strategic asset allocation). Fiduciaries typically consider investment decisions, particularly regarding strategic asset allocation and liability management, across longer, multi-decade timespans. Companies change, business practices change, and consumers' tastes change. Though analysts can make assumptions about trends going forward, any long-term analysis will be dependent on the accuracy of those assumptions.

Top-down models generally begin with climate model outputs and climate scenario considerations and attempt to link these outputs with forecast changes in macroeconomic and broad financial trends over an extended period. While less useful for forecasting performance for portions of an investor's portfolio, these broader variables typically integrate well with whole-portfolio measures of risk exposure, asset class risk and return forecasting. Scenarios like those of the NGFS can use econometric methods to estimate the impact to GDP from physical climate risk, the socioeconomic impact of climate change on GDP, future behavior of interest rates from climate shocks, among others. However, such models are only as strong as their linkages. To the extent that climate models are incorrect versus reality or the estimated linkages between climate data and targeted variables vary, the top-down estimate will necessarily suffer. Though broader macroeconomic variables can have more stable relationships over time than company-specific measures of valuation, they can also vary over time and would potentially become less stable in more extreme climate scenarios.

Given the tradeoffs associated with both bottom-up and top-down approaches, combining the two can offer the strengths of both while mitigating their weaknesses. One way to combine the methods is to use them sequentially, using a top-down approach to identify riskier areas of portfolios (whether they be asset classes, sectors, or companies) and then engage in detailed bottom-up analyses for those areas to better understand and manage specific climate risks. An investor could also conduct both simultaneously, using the output of each analysis to inform insights about the other. Additionally, both types could be used simultaneously but prioritize different areas of inquiry. For example, bottom-up analysis could be used for judging alignment with an investor's climate goals throughout the portfolio while the top-down approach would focus on long-term financial impacts.

A key area of concern for any scenario modeling exercise, whether bottom-up or top-down, is assessing scenario output sensitivity to different scenario inputs. Particularly for longer-duration (i.e., multi-decade) analysis associated with asset allocation and liability management, changes in starting dates and assumptions about the timing of various policy responses will meaningfully impact results over the periods of analysis. Input sensitivity does not invalidate a model, but sensitivities should be understood and mitigated where possible by using a variety of different scenarios with varying inputs to help derive a meaningful set of results.

In summary, ascertaining the impacts of climate change, particularly over a longer time horizon, is a challenging endeavor. Differences in the character, magnitude, or timing of various climate risk factors can radically affect the outcome of the analysis. Climate change impacts are not obvious nor simple to estimate or counteract. Trends indicate that as multiple stakeholders continue to work on providing guidance and resources to support scenario analysis efforts among asset owners and other investors, climate scenario analysis will continue to advance. The varying strengths and weaknesses of different analytical approaches, whether bottom-up, top-down, or hybrid approaches should be acknowledged and accounted.

VII. Conclusions

In this first report, we reviewed high-level global trends in climate change and related developments in financial markets across asset classes, policy and regulatory frameworks, institutional collaboration, and trends in climate risk data, metrics, and climate scenario analyses.

The challenges brought about by physical climate risks and the global energy transition to reduce GHG emissions affect every economic sector and geography. GHG emissions vary widely across industries and between companies within each industry. The complex nature of the transition and the difficulty of energy supply and demand transitioning in lockstep to meet net-zero goals in the timeframe identified by experts, is already producing economic disruptions. The magnitude of the changes underway carry significant government policy and regulatory risks for both traditional companies and low carbon-focused companies. A growing number of companies that are in transition offer both traditional fossil fuel driven and new low-carbon energy products and services. The current uncertainty of many government paths heightens the risks throughout the economy. It is important to underscore that traditional sources of energy will continue to be in demand to meet the diverse needs of businesses, the consumer, and governments for the foreseeable future.

Efforts to address climate change are undergoing rapid change across financial markets, government policies and regulations, institutional collaborations, and in climate investment data, metrics, ratings, and scenario analysis. Developing investment strategies that can best seek to manage climate risks and align with net-zero global ambitions will likely continue to evolve as the world seeks to transition to a low-carbon economy, and as physical climate risks mount. These issues are complex, with no easy answers. In the US today, Meketa finds that most public pension plans do not address climate-related risk and opportunities explicitly in their investment strategy. Among asset owners that actively seek to address investment climate risks and opportunities, there are no established best practices on how best to tackle these issues.

Institutional investor climate strategies are evolving and will likely change significantly within the coming decade. Trends indicate that the early attention to climate focused on the publicly traded equity asset class and, at varying rates, has spread to all major asset classes. Attention is shifting to encompass the Scope 3 emissions of companies – emissions based on a company's inputs, and the emissions generated in the use of products after sale. Biodiversity impacts of climate change are commanding growing attention. The importance to economic and social stability of a just transition that supports those workers and communities most negatively affected is gaining recognition. In addition, there is the realization that decarbonizing an investment portfolio, if disconnected from decarbonization in the real economy, does not address long-term climate risks. Strengthening collaborations among institutional investors is raising the importance of shareowner proxy voting, and engagement with companies, asset managers and governments in managing long-term investment climate risks. Meketa will continue to monitor these trends as they evolve.