



CFA Institute

CLIMATE CHANGE ANALYSIS IN THE INVESTMENT PROCESS



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EXECUTIVE SUMMARY

Our planet is warming, primarily in response to increased levels of carbon dioxide (CO₂) and other greenhouse gases in our atmosphere, which change the climate in numerous ways. The physical and economic impacts of these changes are becoming clearer year by year. Global cost estimates reach into the tens of trillions of US dollars by the end of the century, with the potential to shave off 1/10th of US GDP by that time if no actions are taken to forestall climate change.

CFA Institute has decided to focus on this issue to better understand and lay out the financial industry's role in the efforts to mitigate climate change that have already begun and will only continue to grow. This report aims to help improve knowledge and understanding about how climate risk can be applied to financial analysis and portfolio management. It then informs practitioners how best to incorporate these analyses into their investment processes, based on case studies of firms that are currently integrating climate-related analysis into their investment models.

To inform our understanding about how climate change is included in or omitted from the investment process, CFA Institute surveyed its community on the topic. Currently, about 40% of all survey respondents incorporate climate change information into the investment process. A separate question to a select group of C-level executives found about 75% feel that climate change is an important issue. The gap between these percentages seems to come from a lack of data and disclosure on climate risks from issuers, which we hope that this report and other work in this area can ameliorate.

As the earth's atmosphere warms and the side effects of climate change become more prevalent, more pressure will be placed on everyone, including financial professionals, to take actions that address climate change. To do this important work, financial professionals need a few key tools.

- **A price on carbon**—CFA Institute agrees that a price on carbon is an essential tool in combating climate change, supported by a transparent pricing mechanism that enables financial professionals to reliably incorporate carbon pricing into their analysis of investments' exposure to climate risk. CFA Institute believes that market-

based mechanisms are the most effective way to develop and support carbon pricing. Accordingly, **CFA Institute calls on policymakers to ensure that regulatory frameworks for carbon markets are designed to deliver transparency, liquidity, ease of access for global market participants, and similar standards across jurisdictions, in order to underpin robust and reliable carbon pricing.**

About 40% of all survey respondents incorporate climate change information into the investment process. A separate question to a select group of C-level executives found about 75% feel that climate change is an important issue.

- **Carbon price expectations included in analyst reports**—A realistic market price on carbon will send a price signal that analysts need in order to properly value the externalities that come with greenhouse gas emissions. **CFA Institute recommends that investment professionals account for carbon prices and their expectations thereof in climate risk analysis.** The externality of climate change has a cost, and that cost will be the future impact of climate change on our markets and society. Economists, investors, and policymakers who have studied the issue agree that a realistic price on carbon will allow markets

to accurately price the impact of carbon on the world economy.

- **Increased transparency and disclosure on climate metrics**—Investors should work with issuers to settle on the metrics that matter when assessing a company's climate change strategy. **CFA Institute acknowledges that the investment industry is coalescing around the Sustainability Accounting Standards Board (SASB) and Task Force on Climate-related Financial Disclosures (TCFD) standards for climate-related disclosures, which are the most relevant and succinct climate-related disclosure standards for addressing the materiality of climate-related risks.**
- **Engagement with companies on physical and transition risks of climate change**—Investors agree that climate change is an important issue,

but lack of data and consistent disclosure around climate metrics are holding back climate-related analysis. **We believe investors should engage with issuers to ensure that climate data, scenario analysis, and related disclosures are sufficiently thorough to support robust climate risk analysis in the investment process.**

- **Education within our profession**—Investors need to continue to educate themselves about climate change in order to provide clients with the climate-related analysis they deserve.
- **Policy that complements our efforts**—Investors need to continue to meet with policymakers in order to make sure that investors have the tools they need to do the work of finance—that is, the efficient allocation of capital that helps to tackle the existential threat of climate change.

REPORT

CLIMATE CHANGE EXPLAINED

About 10,000 years ago, humans began to develop agriculture, and about 4,000 years ago, the Sumerians of Mesopotamia developed the world's first civilization. These timescales, although vast to us, are mere blips in geological time. Earth formed about 4.5 billion years ago, and the mass extinction of the dinosaurs happened about 65 million years ago.

During the last 4,000 years that we have spent growing our civilization into the powerful economic engine that it is today, we have been able to take one important thing for granted—our climate.

Not anymore.

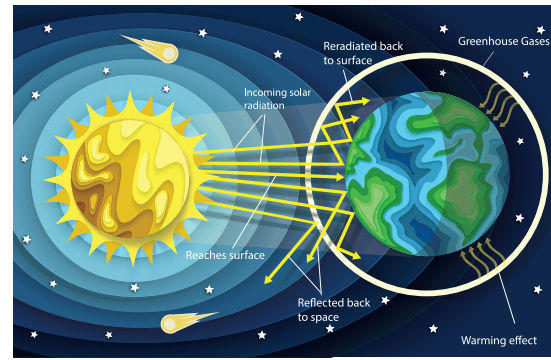
Climate change is a complex problem, and solving it will require large changes in the way we live. Greenhouse gases (GHGs) trap heat in the atmosphere.¹ The more GHGs we put into the atmosphere, the more heat they trap. This ongoing cycle raises the atmosphere's temperature, contributing to several follow-on problems.

When radiation from our sun reaches the earth, it can take a few different paths: It can bounce off our atmosphere or clouds back out into space; it can reach land, oceans, and the planet's population, all of which absorb it as heat; or it can be re-radiated back into space. We need the earth to be able to both reflect and re-radiate solar radiation to prevent the planet from growing ever hotter.

The molecules of GHGs, such as CO₂, methane, and nitrous oxide, absorb some of the heat that would otherwise be radiated back into space. GHGs act as a blanket around the earth. We thicken that blanket by putting more GHGs into the atmosphere (see **Figure 1**). Because of its much higher concentration in the atmosphere, CO₂ is the GHG that contributes most to climate change, although methane and nitrous oxide play a small role as well.

These GHGs are beneficial to a point, because without any CO₂ or other GHGs in the atmosphere, the average

FIGURE 1. GLOBAL WARMING AND THE GREENHOUSE EFFECT



Source: SiberianArt/iStock/Getty Images.

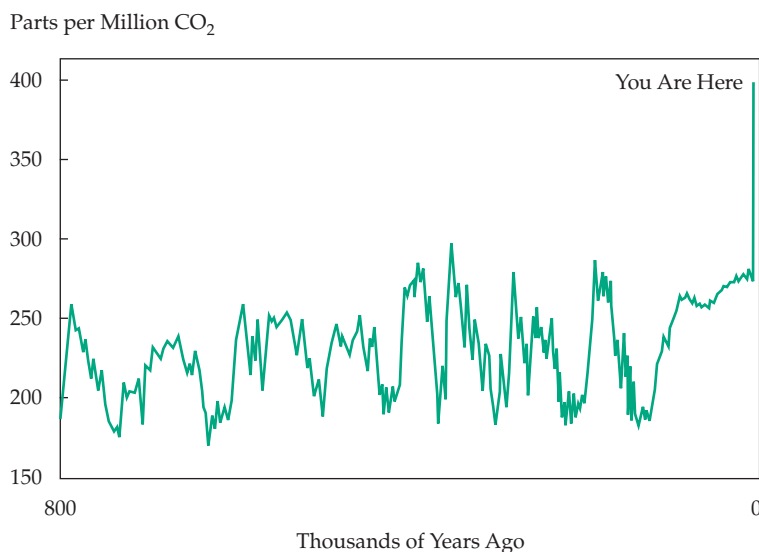
temperature on earth would be about 0° Fahrenheit (–18° Celsius) instead of about 58°F (15°C) that we enjoy today. Life as we know it would not be possible without some GHGs in the atmosphere acting as a warming blanket. These conditions have allowed human civilization to grow during the last 10,000 years. But what we are currently experiencing is too much of a good thing.

Since the industrial revolution, humanity has been pouring vast quantities of GHGs into the atmosphere. Up to a point, our trees and oceans were able to absorb these gases, so the increase did not significantly change the earth's average temperature. But evidence suggests we are now past that point. In order for trees alone to absorb enough CO₂ to mitigate climate change, we would have to reforest a large proportion of land that is currently used for growing food.² That tradeoff—dedicating about 10% of the earth's arable land to forestry—is unrealistic, because it would take away about 40% of the calories currently produced by the world's food suppliers. At this stage, planting trees offers only part of the solution to climate change.

CO₂ can stay in the atmosphere for decades, and our trees and oceans are seemingly beyond their capacity to absorb it. That heat-trapping blanket in

¹NASA, "Scientific Consensus: Earth's Climate Is Warming." <https://climate.nasa.gov/scientific-consensus/>. Multiple studies published in peer-reviewed scientific journals show that 97% or more of actively publishing climate scientists agree: Climate-warming trends over the past century are extremely likely the result of human activities. In addition, most of the leading scientific organizations worldwide have issued public statements endorsing this position.

²Sarah DeWeerd, "We Can't Possibly Plant Enough Trees to Stop Climate Change," *Anthropocene* (30 May 2017). <https://anthropocenemagazine.org/2017/05/we-cant-possibly-plant-enough-trees-to-stop-climate-change/>.

FIGURE 2. HISTORY OF CO₂ IN THE ATMOSPHERE

Source: NASA Global Climate Change, using data from Luthi, D., et al. 2008; Etheridge, D.M., et al. 2010; Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO₂ record.

the atmosphere thickens with each passing year. The CO₂ level in the atmosphere since Sumerian times has bounced between 200 and 300 parts per million (PPM). As **Figure 2** illustrates, it now stands at about 415 PPM and is rising more than 1.0 PPM each year.

Climate change will affect economies and markets in the coming decades at an accelerating rate if we do not bend the PPM curve back toward the x-axis. Even if we eventually do bend that curve, certain changes to our climate in our lifetimes, our children's lifetimes, our grandchildren's lifetimes, and our great-grandchildren's lifetimes are already set and likely irreversible.

It is true that CO₂ PPM levels have been much higher in the history of earth than they have been in human history. Levels of CO₂ in the atmosphere are estimated to have reached nearly 7,000 PPM about 500 million years ago and are estimated to be in the low thousands during the age of the dinosaurs. We have built our societies in a time of much lower CO₂ concentrations, however, and the levels of CO₂ PPM concentrations we can expect in the coming decades will likely lead to a hotter environment that is increasingly hostile to our way of life. The rate at which CO₂ levels are rising may also be increasingly beyond our ability as humans to adapt (these physical risks will be discussed later in the report). Ultimately, climate

change could affect our brains: Research has shown that at about a 945 PPM concentration of CO₂ in the atmosphere, human cognitive ability drops by about 15%.³ With a CO₂ level at 1,400 PPM, cognitive ability is estimated to drop by about 50%.

A hotter planet means more drought, more famine, more extreme weather events, more property damage, and more dislocation of humanity than any of us have seen in our lifetimes. We cannot know when on the calendar these disasters will arrive, but we can be confident that they will.

The investment profession needs to incorporate these new realities into our analysis in order to help efficiently allocate capital in a world where the effects of climate change are increasing. Climate change will impact every company and every investor on earth. Some will indeed benefit, and others may lose everything.

Financial professionals need access to material data on climate change in order to make the most informed investment decisions possible. We need a robust market price on carbon emissions; we need timely, comparable, and audited data on material climate-related metrics; and we need to know how the companies we invest in are responding to climate change.

³Joseph G. Allen, Piers MacNaughton, Usha Satish, Suresh Santanam, Jose Vallarino, and John D. Spengler, "Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments," *Environmental Health Perspectives* (1 June 2016). <https://ehp.niehs.nih.gov/doi/10.1289/ehp.1510037>.

ECONOMIC AND MARKET IMPLICATIONS OF CLIMATE CHANGE

Climate change may be the most economically impactful event in human history.^{4,5} Unfortunately, our profession is for the most part behind the curve in analyzing its effects.

Estimates of the costs of climate change have a wide range, but all contain bad news. A 2015 report by The Economist Intelligence Unit estimated the net present value costs of climate change at US\$4.2 trillion. That estimate tends to be on the low end, however. In a 2019 speech, Sarah Breeden, then the Bank of England's executive director of International Banks Supervision, stated that if no action is taken to mitigate climate change, losses could be between US\$4 trillion and US\$20 trillion. The cost of adapting to climate change in developing countries could rise to between US\$280 and US\$500 billion per year by 2050, according to a recent United Nations Environment Programme (UNEP) report.⁶ The Fourth National Climate Assessment, published in 2018 by the US Global Climate Change Research Program, noted that climate change could slash up to a tenth of US gross domestic product annually by 2100. That figure is more than double the losses of the Great Recession of 2008.

A report published by the J.P. Morgan Economic Research team in January 2020, titled *Risky Business: The Climate and the Macroeconomy*, illuminates the uncertainty around measuring the impact of climate change. The report states that decision making about climate change policy can be difficult because of uncertainty about (1) the path of emissions, (2) the impact of CO₂ concentrations on global temperature, (3) the direct link between CO₂ concentrations and extreme weather events, and (4) how a change in GHG concentrations impacts GDP.

The J.P. Morgan report goes on to explore several studies that have attempted to measure the effects of climate change on GDP. In each case, even under some worst-case scenarios, they highlight that GDP still

grows, just at a slower rate than it would have absent climate change:

At the moment, global GDP is around US\$100tn. At a growth rate of 2% a year, global GDP would reach around US\$500tn at the end of the century. A loss of even 7% ... would still leave the level of GDP in 2100 over four and a half times higher than today.

Look beyond the Numbers

The J.P. Morgan report was met with such headlines as "JP Morgan Economists Warn Climate Crisis Is Threat to Humanity," and "JP Morgan Economists Warn of 'Catastrophic Outcomes' of Human-Caused Climate Crisis." The report does not paint a rosy picture. Yet, an analyst can read the report and easily come away with the message that even a worst-case scenario calls for a global GDP that is four times that of 2019 GDP in 2100.

With such projections, we must keep in mind that we will not see a particular cost assessed at the end of some period (2100, for example). Rather, the economic impacts of climate are better understood as a compounding loss each year, which would leave a much bigger hit by century end than has been suggested by studies that simply quote a single number for costs at the end of the century.

The authors of the J.P. Morgan report warn that although precise predictions are not possible, the earth is on an unsustainable trajectory. They note that a BAU (Business as Usual) climate policy would likely push the earth to a condition that has not been present for many millions of years. Experience over recent decades is not a useful guide to that kind of future.

The models that attempt to measure the economic impacts of climate change all have the handicap of being based on the assumption that societies will go on as they have before, just at a slightly slower pace. But climate change is seen as a potential threat to our very existence.

⁴Estimates for the cost of World War II are at about US\$1.3 trillion (see <https://researchworldwar2.weebly.com/economic-costs.html>). That figure equals about US\$19 trillion in today's dollars, which outweighs most current estimates of the cost of climate change, although the costs of climate change are of course more difficult to measure. Climate change will stretch out farther in time than WWII, so the total cost of climate change will of course be more than US\$19 trillion, but discounted back to today, that number is likely lower than US\$19 trillion. Which event ends up costing more is beside the point. The point is that climate change will be very, very expensive.

⁵This report was written during the height of the 2020 coronavirus pandemic, and we would be remiss if we did not acknowledge the vast financial cost that COVID-19 will have on the world. As of this writing, much of the world is on lockdown, and the trillions spent to try to revive the world economy and the economic cost of lost labor and productivity will still need to be calculated after the pandemic has subsided. Needless to say, both the coronavirus pandemic and the full impacts of climate change will likely run into the tens of trillions of US dollars.

⁶UNEP, 2016 Adaptation Finance Gap Report (May 2016).

Thanks to climate change, we can expect the world to experience increased heat, extreme weather events, loss of food and water sources, and increased mass migrations—all at levels unseen in recorded history. Even leaving aside the problems of increased extreme weather events and problems with feeding and providing water for the approximately 9.5 billion people we anticipate on the planet by 2050, the chemistry of the human body begins to break down with extended exposure to temperatures of about 35°C (95°F), the upper limit of human adaptation to heat stress. Above this temperature, the human body can no longer cool itself in the shade.⁷ At this temperature, evaporation no longer cools the skin. After a few hours in these conditions, most humans will experience hyperthermia and are at grave risk. We can expect to see more days that reach such temperatures with each passing year.

Climate Analysis Takes Imagination ... and Better Data

Climate change is already affecting economies and financial markets, and by its nature, it will do so with more frequency in the future. To exacerbate the matter, today's financial professionals generally have a limited understanding of the issue and few tools for including climate change metrics into their financial models.

Global regulators and standard-setting bodies are increasing their attention to climate change. The European Commission is in the process of creating a taxonomy for sustainable financial activities that aims to place an environmental, social, and governance (ESG) or sustainability framework on the investment industry's activities. This approach places some of the burden of climate change mitigation on the financial profession, although we will need better data from companies in order to adequately meet this challenge. China, Japan, and Canada are in the early stages of developing similar taxonomies. More government intervention on the issue is inevitable.

Blame the Discounted Cash Flow Model ... and Human Nature

The problem of climate change appears custom-made to confound our thinking about investments and financial planning. We learn early in our understanding

of investing—whether through the CFA Program curriculum, an MBA program, a financial class in university, or self-study—that events far into the future should have nearly no present value. We all learn to use a discounted cash flow (DCF) model to value investments, and no matter what discount rate we use (a high rate for riskier investments), cash flows far into the future have next to no present value. Jeremy Grantham humorously points out the ridiculousness of this situation in his article on the problem of climate change, "The Race of Our Lives":

Capitalism also has a severe problem with the very long term because of the tyranny of the discount rate. Anything that happens to a corporation over 25 years out doesn't really matter to them. Therefore, in that logic, grandchildren have no value.⁸

This line of thinking leaves us with a problem when assessing the economic value destruction that climate change will bring—because most of that economic pain will happen more than 30 years from now, and DCF analysis suggests that those numbers do not really matter much.

Our children and grandchildren will live most of their lives 30+ years into the future, as will many current financial professionals. Decisions we make and actions we take today that may have catastrophic effects for people (including ourselves) in the future should not be shrugged off simply because a DCF model says the ramifications of our decisions and actions have little economic meaning.

Ultimately, when our spreadsheets give us answers that do not make intuitive sense, we need to step back and seek better models.

Because the consequences of climate change inaction have thus far been many years away, we were tempted to delay acting until we could see the economic pain closer at hand. Few people have had sufficient incentive to act on such a problem when it is generally future generations that will pay the cost. But because CO₂ stays in the atmosphere for decades, inaction today causes a bigger problem tomorrow. Humanity's relative inaction on climate change up until now has made the task of avoiding the worst effects harder, and each year that passes without profound action makes the task all the more challenging.

⁷Steven C. Sherwood and Matthew Huber, "An Adaptability Limit to Climate Change Due to Heat Stress," *Proceedings of the National Academy of Sciences* (25 May 2010). <https://www.pnas.org/content/107/21/9552>.

⁸Jeremy Grantham, "The Race of Our Lives Revisited," GMO White Paper (2018). https://www.gmo.com/globalassets/articles/white-paper/2018/jg_morningstar_race-of-our-lives_8-18.pdf.

What Investors Can Do

Investors need to educate themselves on the economics of climate change and understand the implications of a heating world on their investments. As we explore in the next section, this includes understanding the risks as well as opportunities that may arise.

To perform this analysis, investors need better data and better reporting standards around climate-related data. They should therefore engage with corporate issuers and policymakers to help inform best practices and standards for climate change-related disclosures.

PHYSICAL RISKS, TRANSITION RISKS, AND OPPORTUNITIES

Climate change has the potential to profoundly change the physical world in which we live. Indeed, some of these changes are already taking place. Summers around the world are already hotter; wildfires are more frequent and more devastating; sea levels have risen around the world, increasing instances of coastal flooding; rainy seasons are rainier; droughts are longer; and extreme weather in general is more frequent.

Climate-related risks to our economies and investments are already here, and they will grow in severity depending on global responses to climate change in the coming decades. Climate change risks are usually divided into two categories: physical risks and transition risks.

Physical Risks

The physical risks are likely the first aspects that come to mind when talking about the impacts of climate change. Most of us have heard about the increase in extreme weather events associated with climate change (stronger and more frequent hurricanes, hotter and drier conditions sparking more forest fires, etc.). These physical changes to our environment will affect every company to some degree. Even if companies do not produce a product or service that directly contributes to introducing GHGs to the atmosphere, GHGs may be in the supply chain of companies that do. Or, they may help finance companies that produce such products or services, or perhaps they will have

employees and clients that consume products or services that contribute to GHGs.

To properly evaluate the risks and opportunities that a changing climate will create for both private and public companies, investors need to be able to identify and evaluate the impact of physical risks associated with climate change.

Increased heat stress on humans—Because of climate change, the world is growing hotter and will continue to do so until GHG levels in the atmosphere stabilize and begin to decrease. Productivity in sectors that require outdoor activity during the summer months will likely be adversely affected. Agriculture, construction, tourism, and other industries will face negative impacts to some degree. Of course, a larger number of heat waves of greater intensity will increase heat-related deaths around the world and even render some localities uninhabitable, because the human body can adapt only so much to heat before its systems begin to break down. Although this phenomenon rarely happens today, it will become more common in the years ahead.

Increased heat stress on assets and infrastructure—The buildings where we live and work, the train tracks and roads we travel on, the cars we travel in, and the machinery we use outdoors will all be challenged by increased heat stress. Prolonged exposure to extreme heat can buckle train tracks and roads.⁹ The vehicles and machinery we use to do our jobs and to travel face a world of increased heat stress that can shave years off their useful lives. From an accounting standpoint, many such assets will suffer from accelerated depreciation schedules, not lasting as long as expected. Companies, municipalities, and countries will thus face more frequent replacement costs for these items.

Increased and more powerful hurricanes and typhoons—Climate change warms the oceans as well as the atmosphere. Hurricanes and typhoons acquire their energy from warm ocean water, and the warmer the water, the more energy these storms can pack. Although it is impossible to declare whether climate change caused a particular hurricane or typhoon, we can expect more of these storms and for them to be more damaging as the planet warms.

Rising oceans and increased coastal flooding—Of course, increasingly powerful storms are not the only negative climate change impact to come from our oceans and seas. As the world warms, glaciers and ice sheets around the world will melt at an increasing rate. At much warmer times in the earth's history, oceans

⁹Climate Central, "Derailments May Increase as 'Sun Kinks' Buckle Tracks," (31 July 2014). <https://www.climatecentral.org/news/climate-change-warp-railroad-tracks-sun-kinks-17470>.

were up to 100 meters higher than they are today—at one time, an inland sea covered much of North America. Such cataclysmic sea rises are not imminent but remind us that the current state of the world is not permanent. Because of climate change, by 2050 land that is currently home to 300 million people will fall below the elevation of an average annual coastal flood. By 2100, land now home to 200 million people could sit permanently below the high tide line.¹⁰

Today, about 110 million people live on land below the high tide line. Defenses, such as levees or people moving to higher ground, could lessen the threat. These defenses will be tested, however, by increasingly rising seas.

Already, cities by the sea—Miami, Venice, Shanghai, Mumbai, and others—are experiencing more frequent flooding, which will only increase further in the coming years.¹¹ Investors in municipalities need to know how cities plan to deal with climate-related challenges. Real estate investors with any exposure to coastal areas will need a better understanding of future flooding expectations, because the flood maps currently used by governments and investors are often based on historical data and are therefore relatively useless.

Extreme weather events—Climate change will make wet places wetter and dry places drier. Warm air holds more water, increasing the likelihood that areas that tend to receive healthy amounts of rainfall will in the future receive too much rain. Monsoon seasons will become more severe. The breadbasket of North America may move north over time, as a forecast combination of too much rain and too much heat in the coming decades could change the viability of staple crops all over the world. In the United States, for example, four of Wisconsin's wettest years on record have come in the past five years.¹² The chances of that happening randomly are astronomically unlikely: The climate has changed.

Climate change also makes dry places drier. A desert climate has an excess of evaporation relative to precipitation. Deserts currently cover nearly 15% of

earth's land area, but that number is likely to increase. As temperatures rise, moderate deserts will become more parched, increasing the instances of forest fires, as we have seen in the western United States and Australia in recent years. As with hurricanes and typhoons, it is difficult to say that climate change caused a specific fire, but a warming planet will increase both the number of forest fires and their expected magnitude and property damage.

Ocean warming/acidification—When we burn fossil fuels, about 50% of the CO₂ emitted remains in the atmosphere, about 25% is absorbed by plants, and about 25% is absorbed by the world's oceans.¹³ Consequently, the oceans are slowly turning more acidic and will continue to do so in the coming decades. Both ocean acidification and ocean warming threaten much of the marine life on which humanity depends as a main source of dietary protein. About 40% of the world's population lives within 100 kilometers of the coast, and 4.3 billion people rely on fish for 15% of their animal protein.¹⁴ Investors need to understand the impact of climate change on our oceans in order to better understand its impact on businesses that depend on the sea and what comes from it for their livelihoods.

Loss of food—Climate change, coupled with a population expected to reach about 9.8 billion by 2050,¹⁵ will challenge the world's food supply. Increased heat stress, increased flooding, and other extreme weather events will challenge the ability of farmers and the world's agricultural businesses to produce enough food to feed everyone on the planet. The production of such staple grains as rice, corn, and wheat is likely to be stressed in coming decades. Investors will need to understand how the challenges of climate change, coupled with changing consumer tastes, will alter the food business around the world. A report from 2009 focusing on corn and wheat production in the United States put numbers to these problems:

Holding current growing regions fixed, area-weighted average yields are predicted to decrease by 30%–46% before the end of the

¹⁰Climate Central, "Flooded Future: Global Vulnerability to Sea Level Rise Worse Than Previously Understood," (29 October 2019).

<https://www.climatecentral.org/news/report-flooded-future-global-vulnerability-to-sea-level-rise-worse-than-previously-understood>.

¹¹Denise Lu and Christopher Flavelle, "Rising Seas Will Erase More Cities by 2050, New Research Shows," *New York Times* (29 October 2019).

<https://www.nytimes.com/interactive/2019/10/29/climate/coastal-cities-underwater.html>.

¹²Wisconsin Public Radio, "2019 Is the Wettest Year Ever Recorded for Wisconsin and the Midwest" (16 December 2019).

<https://www.wpr.org/2019-wettest-year-ever-recorded-wisconsin-and-midwest>.

¹³National Oceanic and Atmospheric Administration, "Ocean-Atmosphere CO₂ Exchange." <https://sos.noaa.gov/datasets/ocean-atmosphere-co2-exchange/>.

¹⁴Global Environment Facility, "Fisheries." <https://www.thegef.org/topics/fisheries>.

¹⁵United Nations, "World Population Projected to Reach 9.8 Billion in 2050, and 11.2 Billion in 2100." <https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html>.

century under the slowest warming scenario and decrease by 63%–82% under the most rapid warming scenario.¹⁶

Loss of water—More than two-thirds of the earth's surface is covered with water, but less than 1% of that water is drinkable. On a planet with the heat dial slowly and constantly rising, making dry areas drier, water and access to it will become a major geopolitical and economic issue in the coming decades. Underwater aquifers are stretched to the breaking point in some areas of India, and Cape Town, South Africa, has been on the verge of running out of water for years, necessitating drastic water usage restrictions that will become more common worldwide. Investors will increasingly need to understand the dynamics of water resources for the businesses, countries, and municipalities in which they invest.

The coming refugee crises—All of the aforementioned physical risks point to an increasing number of displaced people in the coming decades as a result of drought, flooding, extreme weather, conflict around access to food and water, and simply living in places that will become uninhabitable in the coming decades. A recent World Bank Group report estimates that in sub-Saharan Africa, South Asia, and Latin America, climate change will push tens of millions of people to migrate within their countries by 2050.¹⁷ The report projects that without concrete climate and development action, more than 143 million people—around 2.8% of the population of these three regions—could be forced to move within their own countries to escape the slow-onset impacts of climate change. For comparison, the recent refugee crisis precipitated by the Syrian Civil War created about 6 million¹⁸ refugees that stressed the resources of neighboring Jordan, Turkey, and many European nations. Investors need to understand the risk that climate change will displace many people in numbers that we have not seen yet in our lifetimes. This displacement will challenge the resources of neighboring countries, relief organizations, and the global economy.

Transition Risk

Economies around the world will attempt to decarbonize (i.e., dramatically reduce or eliminate CO₂ emissions) in the coming decades. How successful they will be is an open question. Efforts to decarbonize economies are already underway by countries and companies alike. Investor groups, such as Climate Action 100+ and NetZero, are engaging with companies to decarbonize. Currently, about 20% of the world's emissions are covered by some kind of carbon market (more on this later) to put a price on CO₂ emissions, with more expected to come in the future. The most ambitious effort thus far to incentivize decarbonization is the European Union's Sustainable Finance taxonomy. This tool helps investors understand whether an economic activity is environmentally sustainable. The world economy *will* change to a much less carbon intensive one over time; the question remains, at what speed will this happen?

The quicker the transition to a low-carbon or net zero emissions economy, the more jarring that transition will be for companies and the more disruption it will cause to economies and markets. Investors will need to educate themselves on the GHG transition plans of most major markets around the world and ascertain what these changes will mean for each sector and each company in which they invest. For example, according to a 2019 report by BloombergNEF,^{19,20} electric cars are on pace to make up 50% of the global vehicle fleet by 2035. Such a shift will cause massive disruption in the automotive, oil and gas, and energy production industries. Analysts covering these industries and portfolio managers who keenly grasp the dynamics of this transition will be better placed to make informed calls on these industries than their less informed competitors.

All industries will undergo some transition to a lower carbon world. Some will be rapid, some will be slow, and the level of disruption will vary due to government action, consumer preferences, as well as company and investor engagement on these issues.

¹⁶Wolfram Schlenker and Michael J. Roberts, "Nonlinear Temperature Effects Indicate Severe Damages to U.S. Crop Yields under Climate Change," *Proceedings of the National Academy of Sciences* (15 September 2009). <https://www.pnas.org/content/106/37/15594.short>.

¹⁷World Bank, "Climate Change Could Force over 140 Million to Migrate within Countries by 2050: World Bank Report," (19 March 2018). <https://www.worldbank.org/en/news/press-release/2018/03/19/climate-change-could-force-over-140-million-to-migrate-within-countries-by-2050-world-bank-report>.

¹⁸"Migration: An In-Depth Collection of Global Reporting on Refugees, Asylum Seekers, Migrants, and Internally Displaced People," *The New Humanitarian*. https://www.thenewhumanitarian.org/migration?gclid=EAlalQobChMI4ai7-6no6AIVuDICh1abQ2AEAAyAAEgJ6mvd_BwE.

¹⁹World Bank, "Groundswell: Preparing for Internal Climate Migration," (19 March 2018). <https://openknowledge.worldbank.org/handle/10986/29461>.

²⁰BloombergNEF, "Electric Transport Revolution Set to Spread Rapidly into Light and Medium Commercial Vehicle Market," (15 May 2019). <https://about.bnef.com/blog/electric-transport-revolution-set-spread-rapidly-light-medium-commercial-vehicle-market/>.

The oil and gas industry faces the largest threat from climate change transition risk. BNP Paribas's 2019 report "Wells, Wires, and Wheels"²¹ offers an excellent transition risk case study, explaining in great detail the industry's imminent threat from a decarbonized economy in which solar and wind energy power the electric vehicles of the coming decades. BNP Paribas's analysis emphasizes the economic reality that the oil and gas industry is capital intensive and new projects must be profitable for decades to come, yet in the not too distant future, those needed profitable decades will not materialize because of the competitiveness of wind and solar power coupled with an increase in electric vehicles.

The global coal industry offers a preview of what may be in store for the oil and gas industries. Among fossil fuels, coal contributes the most to greenhouse gases per unit of energy output, making it a target for investors, activists, and governments looking to address the issue of climate change. It is economics, however, not activism, that is shrinking the footprint of coal and coal demand. Renewable energy sources, such as solar and wind, are now cheaper than coal in most places, and in response, companies are shutting down coal plants, financiers are shying away from funding new coal plants, and governments pressured by activists and investors can more easily say "no" to coal, citing both economic and environmental issues.

This transition away from coal has and will continue to hit workers in the global coal industry hard. In response, a number of governments are exploring how to undergo a "just transition" from coal. Germany and Spain have both adopted just transition plans addressing the coal industry.²² In Germany, the plan includes more than US\$45 billion dedicated for community assistance and retraining for communities affected by a planned coal phaseout by 2038. In Spain, the government agreed to a €250 million transition plan to support mining regions where nearly all coal mines will be shut down over the next decade in order to reach the country's long-range climate goals. Similar efforts in South Africa, Canada, and other countries are underway or beginning.

Opportunities

Although physical risks and transition risks understandably tend to dominate analysis around the economic and market impacts of climate change, the transition to a less carbon-intensive world will also present several opportunities.

For example, although the carbon intensity of power generation and transportation will likely decline in future years, presenting a challenge to those companies and investors in the utilities and fossil fuel industries that are slow to adjust, the demand for energy and personal mobility will still need to be met. In the future, these needs will increasingly be met by low-carbon power sources and transportation options that take advantage of increased demand for "greener" energy solutions.

Opportunities will not be limited to the obvious energy-intensive sectors. Climate change mitigation will touch every global industry, some more than others. New farming methods and increasing demand for a less carbon-intensive food supply are changing the agricultural landscape already. The financial industry, which an investor would assume is relatively immune from the economic impacts of climate change, increasingly faces investor pressure to cease funding to highly carbon-intensive projects as investors focus more on the whole ecosystem of GHG emissions, including those that finance GHG-intensive industries.

What Investors Can Do

Investors need to understand how the physical and transition risks brought on by climate change will affect the companies in which they invest. Some of these risks are slowly growing threats, and others have already emerged. Investors should understand the expected intensity or frequency of such risks when possible and engage with companies to understand what strategic steps each company has or has not taken to mitigate these risks. At the same time, the immense changes in society brought about by a climate change transition will present opportunities to investors in both established and nascent industries.

²¹Mark Lewis, "Wells, Wires, and Wheels: EROCI and the Tough Road Ahead for Oil," BNP Paribas Investors' Corner (8 February 2019). <https://investors-corner.bnpparibas-am.com/investment-themes/sri/petrol-eroci-petroleum-age/>.

²²Cynthia Elliott, "Planning for a 'Just Transition': Leaving No Worker Behind in Shifting to a Low Carbon Future," World Resources Institute (25 March 2019). <https://www.wri.org/blog/2019/03/planning-just-transition-leaving-no-worker-behind-shifting-low-carbon-future>.

A PRICE ON CARBON: CARBON MARKETS

The most potent tool in combating climate change is undoubtedly a price on carbon. Putting a price on carbon emissions that considers the negative externality of climate change creates an incentive for the invisible hand of the market to move economies away from burning fossil fuels.

Politicians and policymakers around the world know that people do what they are incentivized to do. Tax codes are written with this axiom in mind, because financial incentives are understood as an efficient way to promote behavior that benefits society.

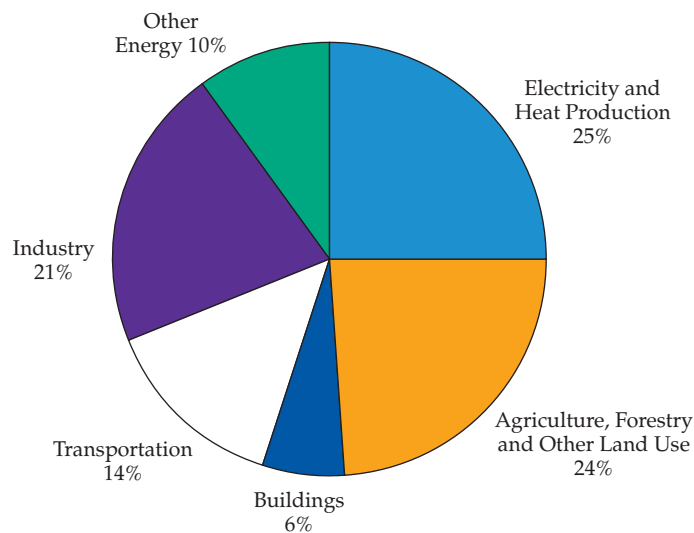
A price on carbon that can incentivize a move away from the burning of fossil fuels that inject CO₂ into the atmosphere is arguably the most effective way to lower carbon emissions. Although CO₂ is not the only greenhouse gas, it does the most damage. The greenhouse gases methane and nitrous oxide stay in the atmosphere longer than CO₂ but are a much smaller part of the atmosphere. Methane makes up about 2 PPM of the atmosphere, and nitrous oxide makes up far less than 1 PPM. CO₂, on the other hand, is at about 415 PPM as of this writing—and rising.²³

Figure 3 shows a rough breakdown of the world's main sources of CO₂. Although energy production is the biggest source of CO₂ emissions globally, policymakers will have to address all large sources of CO₂ to effectively mitigate climate change.

Currently, carbon pricing follows two main methods: a carbon tax and a cap-and-trade system. Under a carbon tax, a fee is placed on carbon-generating activities so that both industries and consumers have incentive to substitute cleaner energy solutions for fossil fuels. Consumers would pay more to fill up their cars with gas, motivating them to move to hybrid or electric vehicles. Energy generation from coal, gas, or other fossil fuels would also become more expensive, increasing demand for non-carbon-based energy sources. Policymakers must find a fine balance when using a carbon tax, however: They must set a rate that will create incentives to decrease the use of carbon-intensive fuels without damaging the economy. In other words, they risk hampering the economy by setting the rate too high or failing to change behavior by setting the tax too low.

The advantage of a cap-and-trade system over a carbon tax is that the total amount of CO₂ released by industry cannot legally exceed a set level. A cap-and-trade system sets a carbon budget for a market, and permits or credits to pollute are sold to users. Companies must buy permits in order to emit CO₂ (or whatever emissions are covered) above the level established by the cap, and these permits can be traded on a secondary market. The cap on emissions is lowered each year in order to incentivize a lower use of carbon-intensive processes. Firms that are low emitters can sell their credits to high emitters, because the carbon credits are assets.

FIGURE 3. GLOBAL GREENHOUSE GAS EMISSIONS BY ECONOMIC SECTOR



Source: Based on data from the Intergovernmental Panel on Climate Change (2014).

²³"Atmospheric Composition," Open Source Systems, Science, Solutions. <http://ossfoundation.us/projects/environment/global-warming/atmospheric-composition>.

At What Price Carbon?

There is a wide band of carbon prices that experts feel are necessary to drive behavior that will create a "2° future," as envisioned by the Paris Agreement that sought to limit global warming to 2° Celsius by 2050. The Stern–Stiglitz Report of the High-Level Commission on Carbon Prices recommends that carbon prices reach the range of US\$40–US\$80/tCO₂ by 2020 and US\$50–US\$100/tCO₂ by 2030, when paired appropriately with complementary policies.²⁴ The 2020 number has not been achieved.

According to the 2019 Climate Leadership Council report "The Case for an Economy-Wide Carbon Fee," however, less than 10% of existing carbon prices in 70 jurisdictions with some active carbon market are at or above US\$40/tCO₂. Furthermore, when carbon prices are weighted to account for the percentage of domestic CO₂ emissions they actually cover, that number falls to less than 5%.²⁵

A price on carbon is not a magic bullet to solve climate change. Governments, companies, and individuals must take other, complementary action to transition the world economy away from carbon-intensive activities at a pace necessary to create meaningful change. Nonetheless, a price on carbon offers a market-based solution as a key step in setting incentives around the world to decrease emissions and eventually bend the PPM curve.

One Last Thing ... a Carbon Border Tax

At the time of this writing, the European Commission is considering a carbon border tax as a potential tool in its efforts to mitigate climate change. Such a mechanism addresses the problem of one country or market adopting a carbon pricing scheme while other markets do not, which gives a potential competitive

advantage (and implicit carbon subsidy) to the market without a price on carbon.

A carbon border tax allows a country that prices carbon to adjust the prices of products from countries that do not, which would eliminate the implicit carbon subsidy enjoyed by the non-carbon-pricing country.

The country with a price on carbon would therefore not face a competitive disadvantage caused by carbon pricing if it implemented a carbon border tax. Such a mechanism would also theoretically incentivize markets without a price on carbon to implement a carbon pricing system in order to avoid paying such a tax on their carbon-intensive exports. As of the date of this report, no market has adopted a carbon border

tax or the less negatively phrased "carbon border adjustment." Still, policymakers continue to consider this tool as a means to help push markets to a meaningful price on carbon.

A **carbon tax** is a fee applied to each unit of greenhouse gas emissions. Finding the right level is key:

- too high, damages economy
- too low, no behavior change

A **cap-and-trade** system places a limit on total emissions but allows participants to trade permits and credits for carbon use, thereby setting a market price.

The major carbon markets are large and liquid, trading in excess of US\$200 billion in 2019.

What Investors Can Do

Investors should educate themselves about how carbon markets work in order to better incorporate a likely higher price on carbon into their analysis. Analysts and portfolio managers should run their own scenario analysis to better understand how a carbon price of US\$50–US\$100/tCO₂ in 2030, as recommended by the Stern–Stiglitz Report of the High-Level Commission on Carbon Prices, would affect the companies they analyze or hold in their portfolios.

CFA Institute recommends analysts begin factoring expected carbon prices into their financial analysis so they can be prepared for a world with more-explicit carbon pricing, whatever form those prices take. See the case study "Carbon as an Emerging Asset Class" for a more in-depth look at the issue of carbon pricing and carbon markets.

²⁴J. Stiglitz and N. Stern, "Report of the High-Level Commission on Carbon Prices" (Washington, DC: Carbon Pricing Leadership Coalition, 2017).

²⁵Climate Leadership Council, "The Case for an Economy-Wide Carbon Fee," (October 2019). <https://clcouncil.org/media/The-Case-For-An-Economy-Wide-Carbon-Fee.pdf>.

SCENARIO ANALYSIS

Scenario analysis, one of the most useful tools for incorporating climate change research into the investment process, applies probabilities to different possible outcomes and decision trees. Investors and analysts can use it to imagine a number of possible different futures in an attempt to assess risk. In the context of climate change, for example, an investor may wish to know the expected value of an asset or portfolio assuming a 1.5°C, 2.0°C, 2.5°C, or 3.0°C rise in average global temperatures by 2050. An analyst may use scenario analysis as a tool to better understand how a company in a climate-sensitive industry (e.g., oil and gas) might be affected by a diverse set of global regulations over the next 10 years.

Scenario analysis trains analysts to use their skills to envision a number of different possible futures for a company or a portfolio so that they can test the sensitivity of returns to a number of different assumptions about prominent risk factors. Scenario analysis becomes particularly useful when addressing climate change, because historical models are ineffective for projecting future climate scenarios.

Analysts and portfolio managers should expect that all companies provide robust scenario analysis, including the strategic decisions that resulted from such scenario planning. Corporate disclosures, however, often fail to present sufficient scenario analysis or its results.

Investors should engage with companies and suggest scenario analysis as a useful planning tool for addressing the effects of climate change. Companies may balk at making public scenario analysis planning because some of the scenarios imagined are worst-case scenarios, something most companies do not like putting in writing. Issuers need not disclose every detail of their internal scenario planning, however, but should disclose enough to show investors that such planning is taking place and make clear how scenario analysis makes its way into strategic planning.

Do It Yourself

Investors should not wait for companies to provide perfect disclosures on scenario analysis on climate change. Rather, they can build their own scenario analysis engines to better evaluate the state of companies or sectors that they follow. Some already have.

Analysts and portfolio managers do not have to invent their own climate-related scenario analysis tools from

scratch, however. Several such tools exist, and we highlight two of the better-known ones here:

- Paris Agreement Capital Transition Assessment (PACTA): PACTA's open source resources aim to help financial institutions integrate climate objectives and risks into portfolio management. To date, more than 1,000 financial institutions have used the PACTA climate scenario analysis tool for listed equity and corporate bonds portfolios, applying it on more than 7,000 portfolios.
- Transition Pathway Initiative (TPI): TPI is a global initiative led by asset owners and supported by asset managers. Aimed at investors and free to use, it assesses companies' preparedness for the transition to a low-carbon economy.

The Benefits of Worst-Case Scenarios

A 2019 report from Australia's Breakthrough—National Centre for Climate Restoration, "Existential Climate-Related Security Risk: A Scenario Approach," provides a good example of scenario analysis applied to the issue of climate change. The title alerts readers that they are in for a blunt assessment of the worst-case scenario around climate change. Indeed, the report paints a bleak picture in discussing a scenario for economies and human civilization itself should leaders fail to tackle climate change.

The report notes that the worst-case scenario need not come to pass if policymakers take vigorous action to address climate change in the near term. If they fail to act quickly and emissions peak in 2030, however, we may see warming of 3.0°C by 2050, with another degree or two of warming expected after that milestone date. This scenario also anticipates sea levels may rise by 2–3 meters by the end of the century, with the potential to rise as much as 25 meters over time because of irreversible feedback loops in the climate system.

The authors discuss this potential scenario and what the world may look like by 2050:

Thirty-five percent of the global land area, and 55 percent of the global population, are subject to more than 20 days a year of lethal heat conditions, beyond the threshold of human survivability.

The destabilisation of the Jet Stream has very significantly affected the intensity and geographical distribution of the Asian and West African monsoons and, together with the further slowing of the Gulf Stream, is impinging

on life support systems in Europe. North America suffers from devastating weather extremes including wildfires, heatwaves, drought and inundation. The summer monsoons in China have failed, and water flows into the great rivers of Asia are severely reduced by the loss of more than one-third of the Himalayan ice sheet. Glacial loss reaches 70 percent in the Andes, and rainfall in Mexico and central America falls by half. Semi-permanent El Niño conditions prevail.

This type of scenario analysis demonstrates its efficacy in telling a story or painting a picture of a future world, allowing us to better analyze the risks inherent in that future world. Investors and analysts can use scenario analysis to better understand a company, a portfolio, an economy, or the world itself.

What Investors Can Do

Scenario analysis offers investors a tool to imagine a number of different climate change scenarios based on their own research and understanding of the probabilities of certain outcomes.

Investors should engage with companies to include more scenario analysis in company disclosures to help investors better understand the possibilities a company faces concerning certain climate-related issues.

CLIMATE CHANGE INVESTOR RESOURCES

For investors to adequately incorporate analysis about climate change into the investment process, they need relevant data on the subject from companies and markets. Currently, these data generally do not exist in any meaningful way across the market. Although some companies do a great job of disclosing greenhouse gas emissions data, they are exceptions rather than the norm. As well, some analysts and fund managers do a great job of integrating climate-related scenarios into their analysis and investment decisions, but these are the trailblazers of climate integration, not typical practitioners.

Carbon markets are a great source of CO₂ pricing, and they will only grow in reliability as a pricing mechanism for investors as more carbon pricing systems are adopted around the world. In the meantime, investors need data and training on how to best incorporate ESG information into the investment process.

CFA Institute designed this report to provide examples of how to integrate climate change-related data into the investment process. We partnered with firms that are already integrating climate-related disclosures into their investment processes to provide real-world case studies that help educate investors about the climate integration process. These case studies include how equity and fixed-income investors are integrating climate change data, how a quant-based firm sees climate data, how a rating agency integrates climate analysis into its process, and many more.

Many of the resources listed in this section provide their own case studies that highlight best practices, and we encourage readers to use these additional resources to enhance their understanding. Integrating climate-related data into the investment process is a new skill that investors must learn, but we believe it will become increasingly important. Financial professionals who are just starting in the industry today will be expected to understand the economic implications of climate change and will need to integrate that knowledge into strategies that will best serve their clients.

The Players

We will not list every single player in the financial world that has done work on climate change. The list is long, and most of the firms we could mention do good work, whether broad in scope or narrow in their purview. Our goal here is to provide investors with what we consider the essential tools of conducting climate change-related analysis. As investors delve into the world, they will continue to discover other tools and resources relevant for their analysis.

TCFD

The Task Force on Climate-related Financial Disclosures (TCFD) recommends that companies disclose climate-related information in four areas so that investors can be better informed about the climate-related risk and opportunities for companies in their portfolios (see **Figure 4**). The TCFD recommends that companies include climate-related information on governance, strategy, risk management, and metrics and targets around climate in their financial filings or other reports in order to provide decision-useful information to investors and others.

The TCFD standards help provide investors with both hard data around a company's climate policy and insights into how a company identifies and manages climate-related risks.

FIGURE 4. THE TCFD DISCLOSURE STANDARDS

Governance	Strategy	Risk Management	Metrics and Targets
Disclose the organization's governance around climate-related risks and opportunities.	Disclose the actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning where such information is material.	Disclose how the organization identifies, assesses, and manages climate-related risks.	Disclose the metrics and targets used to assess and manage relevant climate-related risks and opportunities where such information is material.
Recommended Disclosures	Recommended Disclosures	Recommended Disclosures	Recommended Disclosures
a) Describe the board's oversight of climate-related risks and opportunities.	a) Describe the climate-related risks and opportunities the organization has identified over the short, medium, and long term.	a) Describe the organization's processes for identifying and assessing climate-related risks.	a) Disclose the metrics used by the organization to assess climate-related risks and opportunities in line with its strategy and risk management process.
b) Describe management's role in assessing and managing climate-related risks and opportunities.	b) Describe the impact of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning.	b) Describe the organization's processes for managing climate-related risks.	b) Disclose Scope 1, Scope 2, and, if appropriate, Scope 3 GHG emissions, and the related risks.
	c) Describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario.	c) Describe how processes for identifying, assessing, and managing climate-related risks are integrated into the organization's overall risk management.	c) Describe the targets used by the organization to manage climate-related risks and opportunities and performance against targets.

Source: TCFD.

At CFA Institute, we believe the TCFD standards are the best climate-related disclosure standards currently available. Their simplicity and succinct nature allow investors an avenue of engagement with issuers on climate-related matters without imposing an onerous disclosure burden. The risk management and the metrics and targets portions of the standards call for measurable data, whereas the governance and strategy portion simply asks how a company is managing the climate issue. It is then up to the company to show investors that it is managing climate risks effectively.

SASB

The Sustainability Accounting Standards Board (SASB) focuses exclusively on the materiality of ESG

information, including climate-related data. At CFA Institute, we consider SASB a key research tool for investors looking into climate-related data because of SASB's focus on materiality. A number of ESG data providers offer investors hundreds if not thousands of different ESG metrics and data points. Investors face the same issue with climate-related data: Much more data are available than are material.

We find the SASB structure attractive because the framework focuses only on what is generally agreed upon to be material in a given sector. Investors and analysts can disagree on the definition of materiality of some SASB-recommended data, but such data offer a great starting point or baseline for analysis. Analysts or investors can go beyond the SASB recommendations if they believe that there are more material factors in

an industry than SASB lists in their standards, but the SASB standard in effect whittles down hundreds of ESG or climate-related data points to about a dozen that are the most material.

The SASB standards also treat climate data differently depending on the industry or sector, which makes the information more valuable. For example, the categories of climate-related data that are the most useful to investors in the oil and gas industry will not be the same ones that are most useful in the financial services sector. In the oil and gas industry, investors will likely focus on emissions, whereas in the banking sector, they will be more focused on a bank's financing of GHG-emitting projects.

CDP

CDP began as the Carbon Disclosure Project but now focuses on several environmental issues: climate change, water security, and deforestation. CDP provides useful reports to investors about issuer activity on climate change and has begun requesting information from companies using the TCFD framework in order to ease access to company data and use of that climate data by investors. According to CDP, over the last two decades more than 515 investors with US\$106 trillion in assets have requested company disclosures on climate change, water security, and forests, and more than 8,400 companies have reported on these topics through CDP.²⁶

CDSB

The Climate Disclosure Standards Board (CDSB) is an international consortium of business and environmental non-governmental organizations (NGOs). Its mission is to advance the global mainstream corporate reporting model to equate natural capital with financial capital. Like CDP, CDSB focuses broadly on environmental information and not just climate change. The CDSB standards focus on 12 different requirements to provide investors with useful decision-making information:

1. Governance
2. Management's environmental policies, strategy, and targets
3. Risk and opportunities
4. Sources of environmental impact
5. Performance and comparative analysis
6. Outlook

7. Organizational boundary
8. Reporting policies
9. Reporting period
10. Restatement
11. Conformance
12. Assurance

CDSB also offers investors a great resource in its Reporting Exchange, with details on sustainability reporting requirements and other resources currently available.

Greenhouse Gas Protocol

The Greenhouse Gas Protocol (GHG Protocol) has established a global standardized framework to measure and manage GHG emissions from private and public sector operations, value chains, and mitigation actions. A partnership between World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), GHG Protocol works with governments, industry associations, NGOs, businesses, and other organizations. GHG Protocol established the Scope 1, Scope 2, and Scope 3 reporting systems that many companies use in reporting emissions to investors and stakeholders:

- Scope 1 includes all of a company's direct GHG emissions in the production of its products.
- Scope 2 includes indirect GHG emissions from consumption of energy (electricity, heat) purchased.
- Scope 3 covers other indirect emissions. Sometimes called value chain emissions, these often represent a company's largest source of GHG emissions. For example, automobile emissions produced by burning gasoline are considered Scope 3 emissions, and they often dwarf Scope 1 or Scope 2 emissions from automobile manufacturers.

GRI

The Global Reporting Initiative (GRI), an independent international organization, has been engaged in sustainability reporting since 1997. The oldest of the initiatives listed in this resource guide, GRI focuses broadly on stakeholder concerns related to sustainability, which of course include climate-related issues. GRI's standards consider both internal stakeholders (employees, managers, and owners) and external stakeholders (suppliers, society

²⁶<https://www.cdp.net/en/info/about-us/what-we-do>.

at large, governments, creditors, shareholders, and customers).

Climate Bonds Initiative

The Climate Bonds Initiative, an international not-for-profit organization, promotes investment in projects and assets necessary for a rapid transition to a low-carbon and climate-resilient economy. It issues reports on the green bond market and has established a Climate Bonds Standard and Certification Scheme. The Climate Bonds Taxonomy offers investors, governments, and municipalities a guide to climate-aligned assets and projects in order to help them understand the key investments that will deliver a low-carbon economy.

Finally, Ask the Accountants

Calls by investors for climate change-related disclosures are raising questions for valuation professionals and accounting standard setters about how to incorporate such disclosures into forward-looking estimates. In late 2019, the International Financial Reporting Standards (IFRS) board provided a resource²⁷ to help investors and accounting professionals understand what already exists concerning climate change in the current requirements and offer guidance on the application of materiality. Although the IFRS Standards do not explicitly cover climate change and other emerging risks, the Standards do address issues related to these risks. A brief summary of this IFRS letter appears in the suggested readings section of this report.

In the coming years, accounting standards will likely develop to better account for climate risk disclosure. In shaping these standards, investors need to let regulators and policymakers know what climate-related information they find most useful and what should be explained separately in financial statements. Another reason for such disclosures is to ensure that investors clearly understand underlying climate change assumptions that may or may not be in agreement with management's perspective. Here are a few places to start:

1. **Expected credit losses**—This requires lending institutions to include forward-looking credit risk in provisioning. There is no specific guidance with respect to climate change, but conceptually it needs to be reflected. For example, oil and gas-dependent states or companies could face higher risk of credit losses in investors' eyes.
2. **Insurance liabilities**—If climate change can be linked to an increased mortality rate in certain regions, life insurance provisions need to reflect this information.
3. **Fair value**—The value of an asset needs to reflect any climate-related risk attached to that asset. Commercial property with zero carbon emissions could be more preferable to tenants because it helps them meet their own sustainable and ESG commitments, potentially making the rental income and valuation for such properties higher than for properties that are not curtailing carbon emissions.
4. **Provisions**—Both legally binding (such as cleaning up nuclear plants) and reputational risk (such as safeguarding biodiversity) provisions are important for investors. They will impact the provisioning amount or require additional disclosure.
5. **Impairments**—A negative ESG score or a problem related to climate change could raise the cost of capital for a company and trim its future cash flows. This means climate issues could increase or decrease risk of impairment.

What Investors Can Do

Investors need to familiarize themselves with the TCFD and SASB standards, which are increasingly framing the conversation around climate-related disclosures. More and more, investors are using these standards as a first step in engaging with companies on climate-related issues. Both sets of standards benefit from focusing on climate-related disclosures that are material to investors, and both are relatively simple and straightforward to use and understand.

²⁷Nick Anderson, "IFRS Standards and Climate-Related Disclosures," IFRS (November 2019). <https://cdn.ifrs.org/-/media/feature/news/2019/november/in-brief-climate-change-nick-anderson.pdf>.

CFA INSTITUTE SURVEY DATA

Between 11 March and 30 March 2020, CFA Institute conducted a survey of its global audience to help better gauge investment professionals' understanding of ESG issues and climate change. Here we include the questions pertaining to climate change, which were meant to ascertain how CFA Institute participants are and are not incorporating climate change analysis into the investment process. CFA Institute received 2,913 responses to the survey for a response rate of 3.2%, with a margin of error of $\pm 1.8\%$ at a 95% confidence level.

The survey results suggest a relative lack of pressure coming from the external client base (regulators and investors) on climate change. They also suggest that the climate risk message is still not gaining sufficient traction. This may make it difficult for investment management firms to decide how to respond but also suggests that opportunity still exists.

The results also point out that market-based solutions are still in their early stages of influence. This is a bit of a chicken and egg problem: Investors want better data on climate change from issuers, but issuers can legitimately say that investor demand for such data has not reached a critical mass, and regulators (with some exceptions) are not requiring these disclosures.

When asked whether it is important to have a definitive view on climate change to effectively manage investments today, 75% of senior-level respondents said it is important or very important. Only about 13% said that having such a view was unimportant. The results also show, however, that only about 40% of respondents are currently incorporating climate change into the investment process, even though three-quarters feel that climate change is important for investment management.

This gap seems to come from a lack of data and disclosure on climate from issuers, which we hope that this report and other work in this area can ameliorate. For the first question about climate change views, we asked a group of global CFA Institute participants who are C-suite executives if it was important to have a definitive view on climate change in order to effectively manage investments today. While 75% of senior-level respondents said that such a position was very important or somewhat important, those in Asia Pacific were the most likely to say that it is very or somewhat important (89%), while only 70% of those in the Americas felt the same.

QUESTION 1. IN YOUR OPINION, IS IT IMPORTANT TO HAVE A DEFINITIVE VIEW ON CLIMATE CHANGE IN ORDER TO EFFECTIVELY MANAGE INVESTMENTS TODAY?

	Total	Americas	APAC	EMEA
Sample Size (N)	305	141	73	91
It's very important				
Column %	46%	44%	51%	44%
It's somewhat important				
Column %	30%	26%	38%	32%
Neutral				
Column %	11%	13%	10%	10%
It's somewhat unimportant				
Column %	8%	9%	1%	11%
It's very unimportant				
Column %	5%	9%	0%	3%

Note: APAC stands for Asia Pacific; EMEA stands for Europe, the Middle East, and Africa.

When asked if their organizations incorporate climate risk into their analysis, only about 40% of global respondents said yes (Question 2). Not surprisingly, firms in EMEA were the most likely to incorporate climate risks.

QUESTION 2. DO YOU AND/OR YOUR ORGANIZATION CURRENTLY INCORPORATE CLIMATE RISK INTO YOUR ANALYSIS?

	Total	Americas	APAC	EMEA
N	2,497	1,188	539	770
Yes				
Column %	40%	40%	33%	45%
No				
Column %	60%	60%	67%	55%

Of those who do integrate climate risk into the investment process, they do so mainly because they believe climate change is a material issue (75%) or because of client demand (47%) (Question 3). Of those that do not integrate climate change analysis into the investment process (Question 4), more than half (57%) said it was because of a lack of measurement tools, and 31% said clients do not demand such analysis.

QUESTION 3. WHY DO YOU AND/OR YOUR ORGANIZATION INCORPORATE CLIMATE RISK INTO YOUR ANALYSIS? (SELECT ALL THAT APPLY)

	Total	Americas	APAC	EMEA
N	968	457	172	339
It is material				
Column %	75%	75%	69%	78%
Regulatory requirements				
Column %	20%	16%	24%	25%
Client demand				
Column %	47%	49%	40%	47%
Other reason				
Column %	13%	14%	16%	11%

QUESTION 4. WHY DON'T YOU AND/OR YOUR ORGANIZATION INCORPORATE CLIMATE RISK INTO YOUR ANALYSIS? (SELECT ALL THAT APPLY)

	Total	Americas	APAC	EMEA
N	1,478	704	360	414
Climate related risks are too far in the future to be material				
Column %	10%	11%	13%	7%
Climate risks are not a priority for my investments				
Column %	25%	25%	33%	18%
Lack of measurement tools				
Column %	57%	55%	61%	57%
Not required by regulation				
Column %	26%	20%	34%	27%
No client demand				
Column %	31%	32%	34%	27%
Other reason				
Column %	18%	20%	12%	21%

We asked about demand from clients about climate change in two different ways. First, we asked if our communities face investor demand for portfolios with transition pathways for lower carbon intensity (Question 5). Only about one-third of those surveyed said that they do in fact face this pressure from clients. We also asked a broader question about whether

clients are asking for more from our communities on climate change (Question 6). More than half said no, and about one-third said that they are asking for more information and analysis on climate change. Demand for products that take climate change into account is relatively low; less than 20% of respondents said clients are asking for either current products or new investable products that take climate change into account. Nearly two-thirds of survey respondents in APAC stated that clients are not asking for more on climate change, while in EMEA the split was 50/50.

QUESTION 5. DO YOU FACE INVESTOR DEMAND FOR PORTFOLIOS WITH TRANSITION PATHWAYS FOR LOWER CARBON INTENSITY?

	Total	Americas	APAC	EMEA
N	2,432	1,151	533	748
Yes				
Column %	32%	31%	23%	40%
No				
Column %	68%	69%	77%	60%

QUESTION 6. ARE CLIENTS ASKING FOR MORE FROM YOU ON CLIMATE CHANGE? (SELECT ALL THAT APPLY)

	Total	Americas	APAC	EMEA
N	2,427	1,151	531	745
No				
Column %	55%	54%	66%	50%
Yes, they are asking for more information and analysis				
Column %	32%	34%	24%	36%
Yes, they are asking that current products should take climate change into greater consideration				
Column %	15%	15%	11%	17%
Yes, they are asking for new investable products that take climate change into account				
Column %	12%	12%	8%	15%

We asked our respondents who do include climate analysis in their investment process to tell us more about their focus (Question 7). Numbers were similar for a focus on physical risk (54%) and transition risk (51%), with a bit less than half focusing on credit risk (45%) and stranded asset risk (44%).

QUESTION 7. SPECIFICALLY, WHAT TYPE OF CLIMATE RISK DO YOU INCLUDE IN YOUR ANALYSIS? (SELECT ALL THAT APPLY)

	Total	Americas	APAC	EMEA
<i>N</i>	940	441	171	328
Transition				
Column %	51%	49%	45%	56%
Physical				
Column %	54%	55%	51%	55%
Stranded asset risk				
Column %	44%	47%	38%	45%
Climate Value at Risk (CVaR)				
Column %	14%	14%	16%	13%
Credit risk impact of climate change				
Column %	45%	49%	42%	41%
Other type of climate risk				
Column %	20%	21%	18%	19%

When we asked respondents if there was climate-related information they wanted that they currently did not have (Question 8), just under half said they wanted more on strategy from companies (49%), disclosure from issuers on risk (49%), or scenario analysis (48%). Fewer respondents desired more on climate-related opportunities (39%) or a price on carbon (33%).

QUESTION 8. IS THERE CLIMATE INFORMATION YOU DON'T CURRENTLY HAVE, THAT YOU WANT? (SELECT ALL THAT APPLY)

	Total	Americas	APAC	EMEA
<i>N</i>	2,404	1,139	527	738
No				
Column %	22%	27%	19%	15%
Price on carbon (carbon tax, cap-and-trade system)				
Column %	33%	32%	35%	34%
More on climate strategy from companies				
Column %	49%	46%	49%	52%
Scenario analysis				
Column %	48%	42%	50%	56%

QUESTION 8. IS THERE CLIMATE INFORMATION YOU DON'T CURRENTLY HAVE, THAT YOU WANT? (SELECT ALL THAT APPLY) (CONTINUED)

	Total	Americas	APAC	EMEA
Disclosures from issuers about climate-related risks				
Column %	49%	47%	53%	50%
Disclosures from issuers about climate-related opportunities				
Column %	39%	37%	41%	39%
Other, please describe:				
Column %	2%	2%	1%	2%

We asked about the issue of divestment when it comes to climate change. Very few respondents (5%) thought divestment was more effective than engagement to support a sustainable economy. Far more thought engagement (57%) was more effective. As with the first question in this survey, we asked this question of a group of global CFA Institute participants who are C-suite executives.

QUESTION 9. IN YOUR OPINION, IS ENGAGEMENT OR DIVESTMENT MORE EFFECTIVE TO SUPPORT A SUSTAINABLE ECONOMY?

	Total	Americas	APAC	EMEA
<i>N</i>	304	141	72	91
Engagement				
Column %	57%	58%	58%	53%
Divestment				
Column %	5%	7%	3%	3%
They are equally effective				
Column %	23%	21%	24%	26%
Neither is effective				
Column %	6%	9%	3%	5%
Unsure/Don't know				
Column %	9%	5%	13%	12%

CASE STUDIES

Please visit <https://www.cfainstitute.org/research> for updates and additions.

Aberdeen Standard Investments

ASSESSING THE VIABILITY OF A COMPANY'S DECARBONISATION PLAN

Petra Daroczi

At Aberdeen Standard Investments, we are particularly interested in transition stories from companies that can demonstrate that they have embarked on a journey to decarbonise their operations. Our assessment follows a three-step process: screening, carbon risk assessment, and evaluation of strategy. This framework enables us to objectively measure the viability of decarbonisation and its implications for the company as well as investors.

As an example to illustrate our framework, we will look at Company A, an integrated utility company based in Asia. It generates, transmits, and distributes electricity to residential, commercial, and industrial customers. At the moment, 100% of its power generation comes from fossil fuels, but the company has stated its ambition to move away from heavy-polluting coal and increase the share of natural gas and renewables used to generate power.

Step One: Screening

The first step is looking at absolute, relative, and expansion thresholds to understand whether the company is in alignment with the Paris Agreement's 2°C warming limit. For example, absolute triggers, such as the overall CO₂ the company emits, are useful for identifying which companies will be among the largest emitters. On a relative basis, we can identify if a material portion of a company's operations are in coal-fired power generation. The expansion threshold aids in understanding whether a company has committed to further investing in coal-fired assets. In our framework, we flagged Company A for breaching the "relative basis" threshold because it was generating more than 20% of its power from coal.

Step Two: Carbon Risk Exposure

The second step is carbon risk assessment, which helps us to understand a company's exposure at the asset/operator level. Here we take a deep dive into the characteristics of the operator's physical assets, such

as location, operational lifetime, and fuel mix profile. These elements provide us with important information on several levels. The location tells us whether the company operates in a jurisdiction that has existing or proposed plans for carbon taxation, for example. Asset lifespan tells us about stranded asset risk—the longer a plant's operational lifetime, the higher the risk that it will not be economically viable to exploit it in the future. We also consider the plant's emission profile, including absolute emissions and emission intensity, because the more CO₂ a company emits, the higher the potential for future carbon tax costs. Finally, financial metrics also play a key role in our carbon risk assessment because ultimately, we want to understand whether the company has the ability to limit the effects of increased costs (carbon tax, costs of complying with stricter environmental regulations) on profit. Capital expenditure plans of the company for maintaining coal assets and/or expansion of the coal fleet are also strong indicators of how coal exposure affects its bottom line.

In our example, Company A has a single coal plant that represents approximately 60% of its power generation capacity and is estimated to be operational well into the 2040s. Although its emission track record has not been published, Company A disclosed that it spent more than US\$1 billion a few years ago on a major emission control project. It also disclosed that it has no capital expenditure plans for investing in further coal-fired assets.

Step Three: Carbon Strategy

The third and final step in our analysis is to look for evidence on the viability of the company's decarbonisation plan. What is Company A's strategy in transitioning away from coal? We look for objective, factual disclosures on the overall vision.

Starting at the top, the C-level oversight tells us whether a company has a board-level committee in charge of sustainability and whether key

performance indicators for the energy transition are tied to executive remuneration. We also assess the company's level of effort to communicate with investors, such as through sustainability reports and/or by joining such global disclosure initiatives as the CDP or TCFD. For Company A, we were satisfied to see both that its Sustainability Committee has a primary role in overseeing the management of the group's sustainability issues and that its Audit & Risk Committee is responsible for the assurance of sustainability data.

We assess whether the company has committed to decarbonisation targets and timelines, as well as whether it discloses the types of projects that will bring the company closer to achieving those targets. Company A committed to an early retirement of 50% of its coal units by 2025. It also embarked on a radical fuel mix change from coal to gas through the construction of two new gas-fired power plants by

2020 and 2023. It disclosed the amount of emission reduction that it would achieve from the change from coal to gas-fired power generation. Finally, it set a target to increase the share of renewable energy in its generation mix to 30% by 2030.

Based on these plans, we noted that Company A's risk of coal lock-in is minimal. In other words, the company's current plans suggest that its coal-based share of power generation will dramatically diminish and fall below our initial 20% threshold during the next decade.

Conclusion

Based on our holistic assessment of current carbon exposure and strategy for future decarbonisation, we are supportive of Company A's efforts and believe that the company can play a positive role in climate change transition.

Addenda Capital

USING CLIMATE CONSIDERATIONS TO BUILD POSITIVE IMPACTS INTO FIXED-INCOME PORTFOLIOS

Brian Minns, CFA, Diane Young, CFA, and Barbara Lambert, CFA

Impact Investing

Impact investing, as practiced at Addenda Capital, is an investment approach that seeks to generate both compelling financial returns and positive, measurable social and/or environmental effects.

Impact investing is not the same as sustainable investing, which integrates ESG considerations into investment and stewardship activities, with a focus on generating superior risk-adjusted financial returns. The key differences between sustainable investing and impact investing are intentionality and measurability. Impact investments are made with the intention of generating a positive impact, and those positive impacts must be measured.

In addition to conducting financial and investment analysis that incorporates ESG considerations, we subject each impact investment to an impact evaluation. We first apply the same in-depth fundamental research and analysis used for all of our investments. We then evaluate each security against the criteria we have established for each of our impact focus areas.

Identifying Investments with Positive Climate Impacts

We use 4 impact investing themes with 10 underlying focus areas. Climate change, the largest theme, has three focus areas: renewable energy, clean transportation, and energy efficiency.

Each focus area in the climate change theme has a written summary that outlines the following:

- the societal challenges associated with climate change;
- how investments in the focus area will help address those challenges;
- linkages between the focus area and the UN Sustainable Development Goals;

- likely impact metrics;
- the criteria that must be met in order to be considered an impact investment in that focus area; and
- a reference to a widely accepted authority or standard that establishes that the impact generated by the investment will be positive.

Each summary must be approved by at least two-thirds of Addenda's Sustainable Investing Committee prior to investment in that focus area.

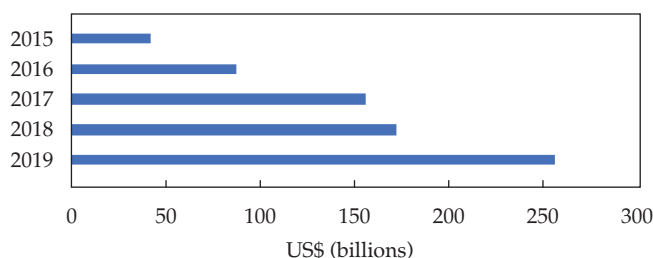
Addenda's sustainable investing team has the mandate to review each possible impact investment to ensure it meets our established criteria.

For climate change impact investments, we seek investments that are aligned with, or supportive of, the transition to a resilient, net-zero emissions society by 2050. In addressing the challenges associated with climate change, we refer to widely accepted authorities or standards that have attempted to establish which activities are necessary and sufficient to support the needed transition. For instance, we refer to the Climate Bonds Initiative's Solar Energy and Wind Energy Criteria for our renewable energy focus area and its Low Carbon Buildings Criteria for our energy efficiency focus area.

Green Bonds—Independently Verified or Second-Party Opinion?

In recent years, the issuance of "green bonds" as labelled by their issuers has grown steadily (see **Figure 1**). Unfortunately, the green bond label does not always reliably indicate whether the use of proceeds will actually support the needed transition. We assess each investment, even those investments already labelled as green, against our established criteria for each focus area.

In some markets, many issuers have their labelled green bonds independently verified against rigorous

FIGURE 1. ANNUAL GREEN BOND ISSUANCE

Source: Climate Bonds Initiative.

standards that meet our own criteria and give other investors confidence that the use of proceeds will help address the challenges associated with climate change. For example, in 2018, 83% of the value of green bonds issued in Australia were certified under the Climate Bonds Standard.²⁸

Another common practice is for issuers to obtain a second-party opinion regarding their green bond program. For example, in 2018, 100% of the value of green bonds issued in Canada had a second-party opinion.²⁹ These second-party opinions tend to focus on the green bond program's alignment with the International Capital Market Association's Green Bond Principles and the issuer's sustainability practices, however, rather than its alignment with the use of proceeds for climate transition. Therefore, it is important for us to review the use of proceeds to ensure they meet or exceed our criteria.

Climate Reporting Is Mandatory

For all impact investing mandates, at least one positive environmental or social impact must be measured and reported to clients annually. This procedure applies to each security within the mandate. Metrics can include tonnes of greenhouse gas emissions avoided, megawatt hours of electricity generated renewably, and kilometers of electricity transmission lines dedicated to moving renewably generated electricity.

Exhibit 1 offers some example metrics.

EXHIBIT 1. CLIMATE REPORTING EXAMPLES

The Whitby Rail Maintenance Facility, one project financed in part by the Province of Ontario's fourth Green Bond, is estimated to have reduced greenhouse gas emissions by 2,093 CO₂e/year.³⁰

The purchase of new subway cars, one thing financed in part by Quebec's Green Bonds, is estimated to have already contributed to the reduction of the greenhouse gas emissions per passenger-kilometer of Montreal's transit system by 6%.³¹

Incorporating Positive Climate Impacts into Fixed-Income Portfolios

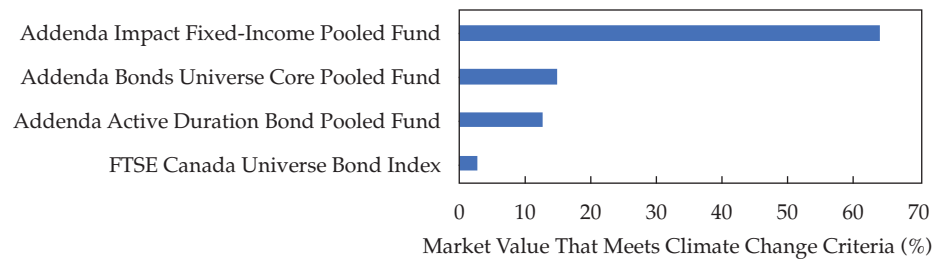
Addenda manages a variety of fixed-income mandates, some of which explicitly prefer positive impact investments. Clients in our Impact Fixed-Income Pooled Fund want a portfolio consisting entirely of impact investments, and climate change is the dominant theme for that investment strategy. On the other end of the spectrum, we work with clients that have not specified a preference for positive climate impact investments, such as those in our Core or Active Duration Bond Pooled Funds. Many of these clients would prefer to invest in those bonds, all else being equal, and so we strive to increase their exposure to

²⁸Climate Bonds Initiative, "Australia Green Finance State of the Market 2019." <https://www.climatebonds.net/resources/reports/australia-green-finance-state-market-2019>.

²⁹Climate Bonds Initiative, "Canada Green Finance State of the Market 2018." <https://www.climatebonds.net/resources/reports/canada-green-finance-state-market-2018>.

³⁰Province of Ontario, "2019 Ontario Green Bond Newsletter." https://www.ofina.on.ca/pdf/2019_ontario_green_bond_newsletter_en.pdf.

³¹Province of Quebec, "Green Bonds Newsletter 2019." http://www.finances.gouv.qc.ca/documents/Autres/en/AUTEN_MFQ_OblVertes_Bulletin_Avril2019.pdf.

FIGURE 2. EXPOSURE TO POSITIVE CLIMATE IMPACT INVESTMENTS

Note: As of 31 March 2020.

Sources: Addenda Capital; FTSE.

positive climate impact within the frameworks of our existing investment processes. Through these efforts, we have greatly increased our clients' exposure to positive climate impact relative to the exposure available in the benchmark (see **Figure 2**).

The Case for Pursuing Positive Climate Impacts

Although it may seem at times that climate change is primarily a risk to be identified and mitigated in existing investment processes, remember that

opportunities exist to provide financing for entities that are taking actions to avert the worst consequences of climate change. The generation of investment returns and social value do not have to be mutually exclusive. It is not only possible but also important to invest in entities that will help us make the transition to a resilient, net-zero emissions society by 2050.

APG APPROACH TO CLIMATE RISK AND OPPORTUNITIES

APG Asset Management is a fiduciary asset manager for pension funds, managing a total of €544 billion as of January 2020. As a leading long-term responsible investor, we regard robust management of climate risks and opportunities as essential to our mission of providing good pensions in a livable world.

Considering that methods for climate-related risk management are still in development, we have established a climate steering group at APG. This group is tasked with overseeing various initiatives to monitor and manage climate-related risks and opportunities within APG, including the prioritization of research. Its members come from various parts of the organization: portfolio management, risk management, and fiduciary management.

Methodology and Instruments

We include climate factors in the analysis used to determine the strategic investment plan for ABP, the pension fund for government and education sector employees in the Netherlands. We began with the central path scenario, based on stochastic modelling. To perform a stress test of this scenario, we constructed four additional deterministic scenarios. Climate change was one of the key factors in constructing these scenarios, along with such other elements as the role of central banks and the strength of international collaboration. One scenario (the "climate pit") reflects a 4°C global temperature increase scenario, and another ("good globalization") is comparable to a < 2°C scenario. We used these deterministic scenarios to map potential effects of climate change for economic growth, inflation, and impact on various asset classes. Also, for each asset class, we developed ESG scores based on a methodology that ranks asset classes primarily for their upside potential for responsible investing. Underlying factors include, for example, involvement by asset owners with investee companies, market transparency within that asset class on ESG-related topics, and percentage of Sustainable Development Investments. We integrated the analysis into ABP's strategic investment plan for 2019–2021.

To map climate-related risks and opportunities in portfolio construction, we conducted scenario analysis at the economic sector level (26 sectors) in collaboration with an external consultant, Environmental Resources Management. To analyze transition risks and opportunities, we followed both a business-as-usual scenario (International Energy Agency Current Policies Scenario [IEA CPS], 3.7°C) and a 2°C scenario (IEA Sustainable Development Scenario [IEA SDS], 2°C), supplemented with specific information from the IEA Energy Technology Perspectives (ETP). Because the IEA scenarios do not cover physical risks and opportunities, we used the RCP 4.5 and RCP 8.5 scenarios to analyze the physical dimension.³² For both transition and physical analysis, we looked ahead to 2022, 2030, and 2040. We chose the year 2022 as the short-term horizon because it is far enough into the future to observe climate impact but also falls within a relevant investment horizon for investments in liquid capital markets (~five years). The years 2030 and 2040 are common intermediate- and longer-term horizons for climate analysis.

Our climate scenario analysis insights are captured in a "traffic light" model. For each economic sector at each time horizon, the model designates both transition and physical climate-related risks as high, moderate, or low. We determined each score using the difference in the value of the key climate factor (selected for the specific sector) between the business-as-usual and the 2°C scenario for the specific time horizon: The larger the difference between those values, the larger the risk or opportunity. For example, in the oil sector, a key risk factor is declining demand for oil. We take the projected demand in IEA CPS and the projected demand in IEA SDS. The larger that difference, the larger the reduction, hence the risk.

The climate factors are defined as key drivers of global climate-related risk and opportunity that may impact the economic sectors in which we invest. Our taxonomy of climate factors (44 in total) is informed by the TCFD list of climate factors, which include carbon pricing, oil demand, litigation risk, and flooding risk. For every sector, a key climate factor has been proposed by the external consultant and validated by APG.

³²RCP stands for "representative concentration pathway," a measure of greenhouse gas concentration trajectories adopted by the Intergovernmental Panel on Climate Change.

Beyond the traffic light model, we have developed a climate dashboard that offers supplementary analysis aiming to track the speed of the transition to a low-carbon economy. The dashboard consists of 20 indicators and is updated annually (versus every two years for the traffic light model). The most prominent changes in indicators and the overall score are analyzed. Therefore, this dashboard supports the assessment and management of climate-related risks and opportunities in a shorter time frame.

We also conduct similar analysis for sovereign bonds at the country level. For each country, we look at physical risk (based on the Notre Dame GAIN database) and transition risk (based on HSBC indicators), resulting in a low-medium-high risk profiling of the sovereign bond portfolios.

Together, the traffic light models for sectors and countries and the climate dashboard are our primary instruments for monitoring climate-related risks and opportunities of our portfolio at a high level. For all investments in areas denoted 'high risk' within the investment horizon, explicit attention should be paid to climate risk in the investment case, including a rationale about why we are prepared to take the risk, as well as the impact of the specific investment on both our and our clients' climate goals.

Most Prominent Risks on Short and Longer Term

The scenario analysis shows that by 2040, the effects of climate change are large and comprehensive. In the run-up to 2040, climate change transition risk increases gradually for a global and diversified portfolio, such as ours. The transition can be accompanied by disruptive changes and unexpected inflection points, however, that will require close monitoring.

Before 2030, we anticipate major transitions already taking place in the 2°C scenarios, with corresponding risks and opportunities for the following sectors in particular: utilities, real estate, cement, oil and gas, aerospace, food and consumer goods, automotive, semiconductors and electrical equipment, agriculture, chemicals, and construction.

Sectors that are especially vulnerable to, but also show opportunities for, the physical impact of climate change include agriculture, forestry, real estate, oil and gas, food processing, road and rail transport, mining, utilities, health care, construction, and water utilities.

From the analysis on climate risks in sovereign debt, we conclude that our exposure to countries with high climate risk (physical and transition) is limited. Countries with lower sovereign credit ratings (emerging economies) are more exposed to climate risk than higher-rated countries, and there is evidence that this exposure is already being priced into investments.

Reporting

Our clients gain insight into our scenario analysis results and the climate dashboard through a digital client reporting tool. We update this report twice a year. Furthermore, we hold deep-dive sessions to brief clients on the monitoring and management of climate-related risks and opportunities. Finally, our fiduciary management department reviews the various asset classes (at least annually) as part of granting and evaluation of mandates. Climate risk is part of this analysis, and we report the results to clients.

New Insights

We have gained the following insights from our climate-related work thus far:

- Scenario analysis provides insights on a generic level about the most prominent impacts of climate change on the overall portfolio. A true understanding of climate-related risk and opportunity for individual investments (including financial impact), however, requires more granular analysis. For this reason, within the APG governance model, the investment teams are primarily responsible for managing climate-related risks and opportunities, whereas overall exposures are monitored and reported across the portfolio. In addition, on a portfolio-wide level, attention needs to be paid to second-order and network effects of climate change, which affect the entire portfolio.
- The scenario analysis conducted in 2018 highlighted the importance of having insight into the macroeconomic spillover effects of climate change. The analysis was based on IEA scenarios that are linear by nature, but in reality, the changes are most probably dynamic and non-linear. Climate change can be seen as not a risk by itself but rather a risk multiplier, with impacts on conflicts, migration, and scarcity that might materialize via such economic variables as economic growth, interest rates, and inflation. For the next iteration of our scenario analysis, therefore, we are considering the addition of

more disruptive scenarios (akin to the Inevitable Policy Response [IPR] scenario developed by the Principles for Responsible Investment [the PRI]). To inform our scenario analysis, we are collecting insights on the underlying patterns of impacts on economies and financial markets, including their speed of recovery, through analogies with historical cases in which physical destruction and major government interventions took place (e.g., natural disasters and wars).

- For the real estate asset class, we conducted a pilot on measuring physical risks. As part of this pilot, we tested six different methods for measuring physical risk on a single asset. The results showed large differences among the six methods, and no single model successfully accounted for all physical risks. We concluded from this analysis that careful interpretation is required in evaluating results from off-the-shelf products. A combination of insights and analysis is essential for complete understanding.

Limitation of the Approach and Next Steps

Measurement, monitoring, and management of climate-related risks and opportunities is in an incipient phase. A number of critical limitations are therefore important to consider.

First, robust quantitative metrics to measure climate risk in portfolios, as well as to integrate this process into regular risk management, are missing. Many (semi-) quantitative metrics and methodologies are becoming available. In practice however, we observe that these metrics depend strongly on models and assumptions, and therefore we do not yet consider these suitable for setting explicit limits on the portfolio with regard to climate risk. Thus far, we have opted to work with a semi-quantitative approach (the traffic light model). We are closely monitoring developments

in this field and are looking to strengthen our approach in the future using more quantitative risk management metrics.

Second, for such asset classes as sovereign debt and such sectors as finance, we observe that climate risks are not direct but rather indirect, based on the underlying economy and financial relationships. Our analysis for the sovereign debt asset class proxies climate risk for countries based on their underlying economies. The next step will be to also make this methodology applicable to financials and proxy climate for companies operating in this sector.

Third, we have developed a dashboard to track the speed of the transition to a low-carbon economy. Currently, this dashboard relies on relatively conventional indicators that use globally available data, such as oil demand and capacity of renewable energy versus fossil fuels. Because these indicators are all backward-looking in nature, we aim to supplement them with some more disruptive forward-looking indicators to enhance our understanding of strong changes in the speed of the transition to a low-carbon economy (e.g., policy developments and social sentiment). We are looking into the possibility of whether innovative technology and data sources, such as unstructured data, can help us enhance the dashboard.

Finally, we have concluded that our scenario analysis does not sufficiently account for the physical risks of climate change. It has merely touched on physical vulnerabilities rather than physical risks. Because we conducted our scenario analysis at a global level, the information is too general to map physical risks for individual investments. We need more detailed information on the physical risks of climate change at a local level for the specific locations where each investment has a footprint. As a follow-up analysis, therefore, we aim to map local physical risks for specific sectors, starting with the real estate asset class.

Campbell Global

INVESTING WISELY AND RESPONSIBLY IN TIMBERLAND ASSETS—A CLIMATE-CONSCIOUS CASE STUDY

Campbell Global (CG), a global investment manager focused on forest and natural resources investments, has nearly four decades of experience in sustainable value creation. As a firm, we are committed to managing our forests in a manner that promotes the best long-term interests of our clients, while also striving to address both economic and ESG considerations.

In addition to their economic value, forests, both natural and commercial, generally serve as vast carbon sinks as trees remove CO₂ from the atmosphere and use it as building blocks to increase growth and carbon storage. As shown in **Figure 1**, in one year, a single Douglas-fir tree (a common commercial timber species in the Pacific Northwest) stores the CO₂ equivalent of driving 400 miles in a standard automobile.³³ Globally, it is estimated that the earth's forests absorb as much as 30% of human-induced CO₂ emissions.³⁴

Sustainably harvested wood products and materials also store atmospheric CO₂ long after they have been

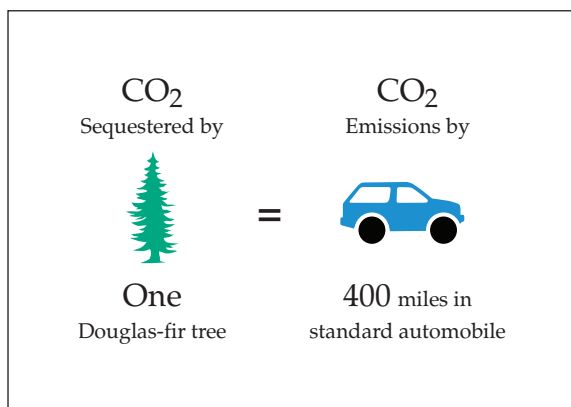
removed from a forest, with one cubic meter of wood capable of storing nearly a metric ton of CO₂.³⁵ In addition to carbon sequestration, forests provide other benefits, including clean water and wildlife habitat, recreational opportunities, and a source of living-wage jobs in rural communities. These attributes positively align with the UN's Sustainable Development Goals and contribute to advancing its mission for a sustainable future for all. For all of these reasons, well-managed forests are a critical component of any global climate change strategy.

At CG, climate-related risks and opportunities are factored holistically into the investment process. We begin by identifying which geographies to include in our investable universe.³⁶ Scenario analyses allow us to identify climate-related risks beginning at a broad country-level scale, then narrowing down to a specific property, and finally testing the impact of various risks to site suitability now and into the future. To gauge climate risks, we include analysis of precipitation patterns, temperature fluctuations, the severity of weather events, presence of pests or disease, and the annual average growth rates for commercial tree species.

Although many climate-related risks in forestry are mitigated through active management, during this iterative process we analyze both the potential positive and negative impacts associated with these risks, allowing us to assess potential changes in net asset value. **Table 1** illustrates climate risks evaluated, their impact on the forest, and what a company can do to mitigate the risks through the investment and active management process.

At a country-level scale, the analysis may lead us to avoid investing in certain regions where the risk of extreme climatic events is too high. For example, we have excluded specific regions within the United States and Australia from our investable universe because of intensifying drought conditions, which increase the risk of both disease and fire within a forest.

FIGURE 1. EXAMPLE OF ANNUAL CO₂ SEQUESTRATION AND EMISSIONS EQUIVALENT



Source: Emissions calculated using the equivalency calculator, available at <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>.

³³Estimated carbon storage of a 20-inch Douglas-fir using the National Tree Benefit Calculator.

³⁴Y. Pan et al., "A Large and Persistent Carbon Sink in the World's Forests," *Science* 333 (19 August 2011): 988–993.

³⁵Oregon Forest Resources Institute (OFRI), "Forest to Frame" (2017).

³⁶We define our investable universe as the core investment regions in the timberland investment asset class, including North America, Oceania, and Latin America.

TABLE 1. CLIMATE RISKS, IMPLICATIONS, AND COMPANY/INVESTMENT STRATEGIES FOR MITIGATION

Climate Risk	Implication	Mitigants
Change in temperature	Increased fire danger	Property-specific fire plans; re-evaluate target regions/country for investment
Change in precipitation patterns	Changes in tree species range; increased drought and related fire risk	Vegetation suitability modeling and genetic tree improvement; re-evaluate target regions/country for investment
Frequency of stochastic weather events	Loss of standing timber from wind events	Re-evaluate target regions; property-specific response plans; geographically diverse portfolio construction
Presence of pests or disease	Early onset and increased frequency of individual tree mortality	If feasible and not detrimental to investment value, plan to treat immediately. Otherwise, pass on the opportunity. If current investment, immediate treatment, which may include removal of affected trees to prevent further spread of pests or disease in the forest
Change in growth	Increased or decreased growth rates	Effects will vary by region, may influence planting stock decisions; re-evaluate forest growth model assumptions

Similarly, following the 2017 fires in Chile, we revised our investment strategy to exclude specific regions within the country that face elevated risk of future forest fires. Because the science is evolving, combined with the increasing frequency of landscape-level disturbances, we routinely test our assumptions and re-evaluate our views on risk-adjusted investment strategies.

After identifying investment regions and incorporating them into an investment strategy, we follow a due diligence process to identify both challenges and opportunities related to climate change. This process enables us to mitigate risks and attempt to increase both the ecological and financial value of the forest for our investors. Furthermore, governance through our investment committee policies and procedures enables us to be flexible and opportunistic, allowing us to adapt quickly as new information develops in response to the evolving nature of climate change science and related public policy developments.

Here are some specific examples of how we have identified climate change-related opportunities and challenges in the investment process:

- Developing pilot projects to evaluate the monetization of carbon offset credits through our strategic alliance with Bluesource, a leader in environmental markets;
- Identifying afforestation opportunities that mitigate climate change by sequestering CO₂ from the atmosphere into trees and soil, which also offers

many important benefits for communities, biodiversity, and soil and water quality;

- Quantifying our carbon footprint and managing transition risks by minimizing CO₂ emissions associated with forest management and manufacturing activities;
- Protecting existing carbon stocks by minimizing the effects on carbon stored on the forest floor through tailored forest management practices;
- Enhancing forest carbon sequestration by replanting areas as soon as possible so the new forest will quickly begin removing CO₂ from the atmosphere;
- Certification and compliance with third-party, verified sustainable forest management standards;
- Participating in academic cooperatives to stay abreast of new research findings; and
- Minimizing potential emissions and losses from forest fires by developing property-specific fire plans and engaging directly with local first responders to prepare for emergency events.

Climate Accounting—For Dollars and Sense

As an early entrant into the regulated carbon trading markets with our McCloud River Carbon Project in Northern California, we positioned our client to

monetize the additional carbon stored on an existing conservation easement. From 2007 to 2014, the carbon project created more than 260,000 metric tons of compliance-grade carbon offsets—the equivalent of the annual emissions from 56,000 cars. Recently, we verified an additional 184,000 metric tons of carbon offsets that were sequestered on the property from 2015–2017. Because of the project's success, we continue to analyze existing land holdings and acquisitions to assess the potential for new carbon sequestration projects.

The ability to quantify, evaluate, and report year-over-year changes in the carbon footprint of a forest can influence an organization's impact on the environment, leading to increased transparency and more informed business decisions. In 2019, CG and OneFortyOne Plantations Holdings Pty Ltd³⁷ (OFO) completed the first comprehensive carbon footprint report for OFO, a sustainable forest grower and forest products company in Australia and New Zealand. This project not

only provided investors with important data but also enabled OFO to further minimize its carbon footprint. The life-cycle analysis of OFO assets estimated the CO₂ emissions associated with its tree planting, operations, harvesting, transportation, processing, and product life. The results were very positive, revealing a net carbon savings equivalent to taking nearly 184,500 cars off the road every year, or a reduction of 860,000 net tons of CO₂ during the reporting period.

Conclusion

At CG, we believe that incorporating climate change factors into our investment process not only mitigates climate-related risks but also promotes and enhances the natural solutions forests provide. Understanding and measuring the comprehensive carbon stores within forests may lead to business decisions that improve carbon sequestration, a critical factor in addressing climate change.

³⁷CG established OFO in 2012 with a consortium of investors to invest in timberland and related assets in Australasia.

CARBON AS AN EMERGING ASSET CLASS

Mike Azlen, Alex Child, and Glen Gostlow

Emissions trading systems (ETs) have proven to be an effective and efficient form of carbon pricing and are an important climate policy instrument, with the ability to mitigate climate change on a large scale. Achieving Paris Agreement climate targets will require the widespread use of carbon pricing to steer the world onto a low-carbon pathway. ETs cap and reduce emissions through tradable emissions allowances that induce emissions reductions at the lowest total cost to society.

All long-established ETs have exchange-listed futures markets to enhance liquidity and price discovery, facilitating greater market efficiency and increasing demand within the market. Compliance entities can also hedge their exposure to future price increases. A listed and liquid market allows investors to actively participate in these markets. In 2019, the traded value of three major programmes—the EU ET, the Regional Greenhouse Gas Initiative (RGGI),³⁸ and the Western Climate Initiative (WCI)³⁹—exceeded \$250 billion.

For investors, carbon traded in these markets can be viewed as an attractive asset class with well-understood risk premium drivers. This case study provides a high-level introduction to ETs as a policy tool for mitigating emissions and also highlights carbon as a potentially attractive asset class for investors.

Emissions Trading Systems Explained

Carbon pricing is a policy that aims to reduce carbon emissions by requiring emitters to internalise the societal costs of emissions. Putting a price on externalities, such as carbon emissions, is the most widely accepted means to efficiently correct for this type of "market failure." Pricing emissions provides a direct economic incentive to reduce them or seek low-carbon alternatives. The two main carbon pricing policy instruments are carbon taxes and ETs (cap-and-trade programmes, also called compliance carbon markets). A carbon tax places a fee on the carbon emissions content of fossil fuels, and the market then determines

the resulting quantity of emissions reductions. An ET places a cap on the total quantity of emissions and allows the market to determine the price for tradable emissions allowances.

ETs allow for environmental certainty and least-cost emissions reductions. In an ET, polluting entities covered by the instrument must submit an emissions allowance for each tonne of greenhouse gas (GHG) they emit. Compliance is mandatory for eligible entities, and their emissions are tightly monitored and audited, with penalties for non-compliance. Entities either purchase allowances through government auctions or, in the case of industries exposed to international competition, receive a portion of allowances through free allocation. A total cap on emissions allowances guarantees that emissions reduction targets will be met, whereas the trading of emissions allowances ensures that the reductions will occur at the lowest total cost to society. Emissions trading incentivises firms with lower abatement costs to maximise their emissions reductions and sell allowances to firms that can only reduce emissions more expensively.

Table 1 summarises the three generic types of carbon markets. ETs are the most liquid and robustly regulated form of carbon markets. International carbon markets allow the transfer of project emissions reductions among different countries. Voluntary carbon markets provide carbon "offsets" that individuals and companies typically use to offset their carbon footprint. These markets aim to increase the cost-effectiveness of achieving global emissions reductions.

ETs have helped stimulate significant emissions reductions and other co-benefits without reducing economic growth. The EU, RGGI, and WCI ETs are among the longest running ETs globally. The jurisdictions covered in each of these markets have experienced positive GDP growth with reductions in emissions since their inception, as shown in **Figure 1**. In achieving the emissions reductions, the EU ET has facilitated significant levels of coal-to-gas fuel

³⁸The RGGI currently covers 10 US states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont.

³⁹The WCI is the California cap-and-trade programme, which has been combined with the Quebec ET since 2014.

TABLE 1. THREE TYPES OF CARBON MARKETS

Market Elements	ETS Carbon Markets	International Carbon Markets	Voluntary Carbon Markets
Description	<ul style="list-style-type: none"> Mandatory participation for large emitters Some allow limited amount of international Clean Development Mechanism (CDM) credits 	<ul style="list-style-type: none"> The CDM was the first major international market under the Kyoto Protocol Emissions reductions transferred across countries 	<ul style="list-style-type: none"> Independent markets for non-regulated entities to voluntarily reduce emissions Variety of industry-created standards
Current Status	<ul style="list-style-type: none"> Covers 8% of global emissions, growing to 14% with the launch of the China ETS 	<ul style="list-style-type: none"> Large market, currently stagnating Article 6 of the Paris Agreement aims to reignite international markets 	<ul style="list-style-type: none"> Mainly used for corporate social responsibility (CSR) activities Attractive for small projects
Regulation	<ul style="list-style-type: none"> Highly regulated, with robust monitoring, reporting, and verification (MRV) 	<ul style="list-style-type: none"> UN-recognised accounting methodologies, such as Gold Standard (GS) accounting 	<ul style="list-style-type: none"> Low to no regulation, different accounting methodologies with varying degrees of rigour
Liquidity	<ul style="list-style-type: none"> Highly liquid In 2018, more than US\$200 billion traded in the WCI, RGGI, and EU ETS 	<ul style="list-style-type: none"> Medium liquidity Average of US\$14 billion traded per year since 2006 	<ul style="list-style-type: none"> Low liquidity In 2018, nearly US\$300 million traded
Carbon prices	<ul style="list-style-type: none"> Range from US\$5.7–US\$31.5/tCO₂e 	<ul style="list-style-type: none"> Range from US\$0.2–\$US0.4/tCO₂e 	<ul style="list-style-type: none"> Range from US\$0.1–US\$70/tCO₂e

switching in the power sector, which also provided substantial health benefits from reduced particulate matter and improved local air pollution. In the RGGI, emissions reductions in the power sector were accompanied by power price reductions, even as power prices rose in the rest of the United States.⁴⁰

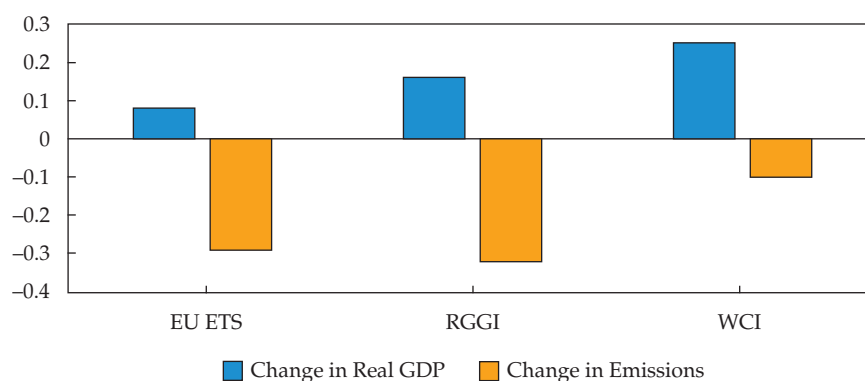
Policymakers have now widely implemented several key policy design improvements that strengthen both the resilience and the environmental effectiveness of ETSs. During the 2008–09 recession, EU ETS GDP declined by around 10% and the carbon price declined from a high of around €30 to a low of around €10. Although a prolonged global recession could still negatively impact carbon prices, modern markets have enhanced features to reduce the impact of an economic downturn on carbon prices and support the robust functioning of this market. These key design features of ETSs, including increasing use of auctioning, free allocation based on efficiency

benchmarks, and supply adjustment mechanisms, determine the stringency of a market and influence the expected future trajectory of carbon prices.

Carbon as an Asset Class

Carbon has become a liquid and investable asset class that now trades approximately US\$1 billion per day across physical carbon, futures, and options. Carbon has exhibited attractive historical returns and a low correlation with other asset classes, making it potentially attractive within a diversified portfolio. Because of the design parameters of an ETS, including the objective of higher prices and lower emissions, there is a well understood and logical case for a forward-looking risk premium for carbon. At Carbon Cap Management LLP (Carbon Cap), we have created an equally weighted multi-market Carbon Composite time series of allowances prices across

⁴⁰Acadia Center, "The Regional Greenhouse Gas Initiative: Ten Years in Review" (2019). <https://acadiacenter.org/document/the-regional-greenhouse-gas-initiative-ten-years-in-review/>.

FIGURE 1. CHANGE IN EMISSIONS AND REAL GDP IN THREE CARBON MARKETS SINCE THEIR INCEPTION

Note: Dates covered include EU ETS: 2005-2018, RGGI: 2009-2018, WCI: 2012-2018.

Source: Carbon Cap based on Eurostat (2019); European Environment Agency (2019); RGGI Inc (2018); Bureau of Economic Analysis (2019); California Air Resources Board (2018); ICAP (2019).

four major long-standing ETSs:⁴¹ the EU, RGGI, WCI, and New Zealand ETSs. We use this composite to examine the statistical properties of carbon markets from an investment perspective, and for the 2012–19 period, we find the following:⁴²

- The Carbon Composite has generated an annualised return of 22% since 2012 and a Sharpe ratio of 1.08, reflecting a higher risk-adjusted return than traditional asset classes.
- Carbon as an "asset class" has exhibited no correlation with other asset classes, making it potentially attractive as a portfolio diversifier.
- Carbon has a prospective annualised risk premium up to 2030 of between 6% and 12%, based on current prices and climate policy objectives.

The Composite generates significant annualised returns and higher risk-adjusted returns relative to global equity and bond markets. **Table 2** illustrates the performance of the Carbon Composite against

traditional equities, bonds, and commodities.

Aggregating the carbon markets significantly reduces the overall volatility of carbon as a commodity: The Composite exhibits a standard deviation of 19.7%, compared with the average standard deviation of the four individual markets at 39%. Although the Composite still has a high volatility, its Sharpe ratio—measuring risk-adjusted returns—is higher (1.08) than those seen in traditional asset classes, which range from -0.70 to 1.02. Further analysis indicates that there is no statistically significant correlation between the Composite and traditional and alternative asset classes.

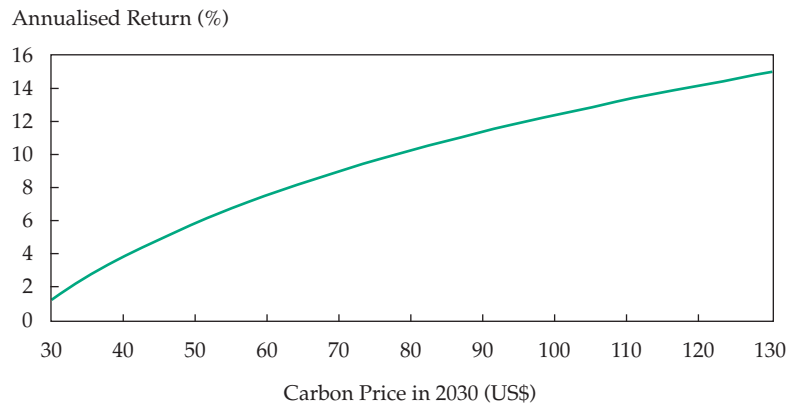
Although carbon pricing, particularly emissions trading, is becoming increasingly widespread, prices will need to rise significantly over the next decade in order to stimulate the emissions reductions required to stay below the Paris Agreement temperature threshold. A total of 36 national and 23 sub-national jurisdictions have currently implemented some form of an ETS,

TABLE 2. CARBON COMPOSITE STATISTICS 2012–19

Financial Properties	Carbon Composite	MSCI World Index	Barclays Global Bond Index	Bloomberg Commodity Index
Annualised return	22.1%	10.8%	3.6%	-6.9%
Annualised volatility	19.7%	10.8%	2.6%	11.2%
Sharpe ratio	1.08	0.92	1.02	-0.70

⁴¹This continuous contract series reflects true returns to an investor based on the allowance price. Where futures contracts are used, we assess open interest and volume to determine the optimal roll window and combine futures time series to account for the roll yield.

⁴²We begin the analysis from 2012 as this is the earliest date when all four markets operated simultaneously.

FIGURE 2. PROJECTED ANNUALISED RETURN VS. FUTURE CARBON PRICES

Source: Carbon Cap.

covering 9% of global annual emissions and 42% of global GDP.⁴³ A further 9 jurisdictions are in the process of putting an ETS in place, and another 15 jurisdictions are considering doing so.

The majority of emissions covered under a carbon price, however, have a price of less than US\$10/tCO₂e. Numerous academic studies suggest that carbon prices need to rise between US\$50 and US\$100/tCO₂e by 2030 to be consistent with Paris Agreement goals.^{44,45,46,47} As such, carbon prices will need to rise substantially if we are to successfully stimulate emissions reductions on the scale required. Based on these price targets, we calculate a prospective risk premium of 6% to 12%, based on a 2% risk-free rate, as shown in **Figure 2**.

Conclusion

The world's current greenhouse gas emissions trajectory will continue to result in dangerous and costly climate change impacts, both societally and economically. The earth is on course for an average temperature increase of 3–4°C by 2100 unless CO₂

emissions are reduced.⁴⁸ Climate change of this magnitude will result in substantial human migration, regional conflicts over increasingly scarce resources, and extreme weather events, causing devastating physical damages and economic costs. Carbon pricing is an essential tool that works within a market economy to change behaviour and reduce emissions at scale in order to avoid the worst damages of climate change.

ETSs are the most cost-effective means of carbon pricing, with a high degree of environmental integrity, and they have evolved substantially over the past decade. Through the combination of an annually declining emissions cap and emissions allowance trading, ETSs provide the environmental certainty of achieving emissions reduction targets with the economic benefit of incentivising this to occur at the lowest possible cost. ETS markets have evolved substantially since their inception, with modern policy design features providing for more stringent markets and greater market resilience in the event of unexpected demand shocks.

⁴³International Carbon Action Partnership, "Emissions Trading Worldwide: Status Report 2020" (2020). https://icapcarbonaction.com/en/?option=com_attach&task=download&id=677.

⁴⁴A. Brown, "UK REA Bioenergy Strategy: Phase 3—Delivering the UK's Bioenergy Potential" (2019). <https://www.r-e-a.net/wp-content/uploads/2019/10/Bioenergy-Strategy-Phase-3.pdf>.

⁴⁵Carbon Pricing Leadership Coalition, "Report of the High-Level Commission on Carbon Prices" (2017). <https://www.carbonpricingleadership.org/report-of-the-highlevel-commission-on-carbon-prices>.

⁴⁶International Energy Agency, "Energy Technology Perspectives 2017: Catalysing Energy Technology Transformations" (2017). <https://www.iea.org/reports/energy-technology-perspectives-2017>.

⁴⁷International Institute for Applied Systems Analysis, "IIASA SSP 2 Degrees Scenario," Shared Socioeconomic Pathways (SP) Scenario Database (2019). https://iiasa.ac.at/web/home/research/researchPrograms/Energy/SSP_Scenario_Database.html.

⁴⁸Intergovernmental Panel on Climate Change (IPCC), "Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty" (2018). Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.). In Press.

Carbon (emissions allowances from ETSs) has emerged as a liquid and investable asset class that may be attractive for long-term investors because of its liquidity, correlation properties, and prospective risk premium. Carbon has generated impressive historical returns, and although it has exhibited high volatility, its risk-adjusted returns have outperformed

traditional asset classes, such as equities, bonds, and commodities. If carbon prices rise to US\$50–100 by 2020, which many estimate would be required for global emissions to be aligned with Paris Agreement goals, this would give rise to a prospective risk premium of between 6–12% to 2030.

Fitch Ratings

PHYSICAL RISKS OF CLIMATE CHANGE: ASSESSING GEOGRAPHY OF EXPOSURE IN US RESIDENTIAL MORTGAGE-BACKED SECURITIES

David McNeil

Property damage from physical climate risk has become increasingly common. According to the US National Oceanic and Atmospheric Administration, 119 weather and climate disasters that each entailed more than US\$1 billion in property damage have occurred in the United States since 2010—roughly twice the number of such events that occurred in the previous decade. Globally, economic losses from natural disasters reached US\$133 billion in 2019, only around US\$56 billion of which were insured, according to the Swiss Re Foundation.

The frequency and magnitude of these disasters are projected to intensify in the coming decade, with the southern United States particularly exposed to heightened hurricane and flood risks. The rising risk of property value loss related to catastrophic events increases the importance of distinguishing projected mortgage pool losses between pools, based on exposure to natural disaster risk. Geographical characteristics (concentration, insurance coverage) can heavily influence probability of default (PD) emerging from natural disasters, but it is important to understand the extent to which these risks are managed. **Figure 1** shows the average cost of damages from severe weather in the United States.

Natural Disaster Risk in Real Estate Securities Transactions

At Fitch, we use a two-layer approach to integrating climate risk into US residential mortgage-backed security (RMBS) loan loss expectations:

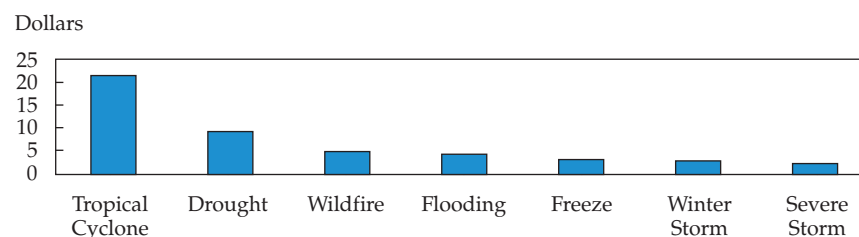
1. **Implicit adjustment:** The methodology implicitly considers natural disaster and catastrophe risk based on past natural disasters in the historical dataset used to develop the loan loss model; geographic concentration penalties (e.g., RMBSs with greater concentrations in California and Florida will be affected more than those concentrated in other states); and rating scenarios that assume severe housing and economic stresses.
2. **Explicit adjustment:** Further adjustment is made through an additional penalty (or credit) layered on to rating stress assumptions detailed in the aforementioned implicit adjustments. The additional adjustment includes projected property losses from storm surge, inland flooding, and earthquakes, but it does not explicitly consider the risk of disasters that are typically covered by standard homeowners insurance (e.g., fire damage or wind damage from tornadoes). The adjustment is intended to better distinguish among RMBSs with different levels of estimated natural disaster risk.

Fitch uses the estimated property losses from future catastrophic events to reduce each borrower's current property value when projecting credit losses. The reduction in the current property value negatively affects the borrower's loan-to-value ratio and, consequently, influences both projected probability of default and projected loan losses on those defaults.

ESG Relevance Scores

Fitch's approach to sustainable finance and climate risk is to provide better transparency on ESG-related

FIGURE 1. AVERAGE COST OF SEVERE WEATHER EVENTS IN THE USA, 1980–2019 (US\$ BILLIONS)



Source: NOAA (2020).

credit risks that influence credit ratings. We have achieved this goal through our ESG Relevance Scores, which have been fully integrated into our existing research process.

Our analysts systematically evaluate ESG credit considerations that are incorporated into ratings methodologies. When assessing credit transactions, analysts will refer to the asset class and sector ESG templates to allocate overall and individual E, S, and G Relevance Scores. One such element in the case of

catastrophe risk is "Exposure to Environmental Impacts." **Figure 2** shows the ESG template for RMBS transactions.

Fitch Ratings' ESG Relevance Scores, illustrated in **Figure 3**, reveal how our analysts integrate ESG credit considerations into their credit analysis and ratings. A score of 5 represents ESG issues that currently have a direct impact on the rating all by themselves, and a score of 1 represents ESG issues that have no credit impact or are irrelevant to both the entity and the sector from a credit perspective.

FIGURE 2. ESG TEMPLATE FOR RMBS TRANSACTIONS

Environmental	Sector-Specific Issues
GHG Emissions & Air Quality	n.a.
Energy Management	n.a.
Water & Wastewater Management	n.a.
Waste & Hazardous Materials Management; Ecological Impacts	Environmental site risk and associated remediation/liability costs, sustainable building practices, including Green building certificate credentials
Exposure to Environmental Impacts	Asset operations and/or cash flow exposure to extreme weather events and other catastrophe risk, including but not limited to flooding, hurricanes, tornadoes, and earthquakes
Social	Sector-Specific Issues
Human Rights, Community Relations, Access & Affordability	Accessibility to affordable housing
Customer Welfare—Fair Messaging, Privacy & Data Security	Compliance risks including fair lending practices, mis-selling, repossession/foreclosure practices, consumer data protection (data security)
Labor Relations & Practices	n.a.
Employee Wellbeing	n.a.
Exposure to Social Impacts	Macroeconomic factors and sustained structural shifts in secular preferences affecting consumer behavior and underlying mortgages and/or mortgage availability
Governance	Sector-Specific Issues
Rule of Law, Institutional and Regulatory Quality	Jurisdictional legal risks, regulatory effectiveness, supervisory oversight, foreclosure laws, government support and intervention
Transaction & Collateral Structure	Asset isolation, resolution/insolvency remoteness, legal structure, structural risk mitigants, complex structures
Transaction Parties & Operational Risk	Counterparty risk, origination, underwriting and/or aggregator standards, borrower/lessee/sponsor risk, originator/servicer/manager/operational risk
Data Transparency & Privacy	Transaction data and periodic reporting

Source: Fitch Ratings.

FIGURE 3. ESG RELEVANCE SCORING DEFINITIONS

Lowest Relevance		Neutral	Credit-Relevant to Transaction	
1	2	3	4	5
Irrelevant to the transaction or program ratings and irrelevant to the sector.	Irrelevant to the transaction or program ratings but relevant to the sector.	Minimally relevant to ratings, either very low impact or actively mitigated in a way that results in no impact on the transaction or program ratings.	Relevant to transaction or program ratings, not a key rating driver but has an impact on the ratings in combination with other factors.	Highly relevant, a key transaction or program rating driver that has a significant impact on an individual basis.

Source: Fitch Ratings, "Introducing ESG Relevance Scores for Structured Finance and Covered Bonds" (15 October 2019).

Investors use Fitch's ESG Relevance Scores to understand the level of credit-specific ESG risk being captured in the credit ratings of entities or transactions in their portfolios. ESG Relevance Scores also assist investors in assessing whether they need to consider and/or incorporate additional downside risk or upside potential related to ESG credit considerations into their credit analysis and models.

Two Contrasting Examples of Risk Exposure and ESG Relevance

BRAVO Residential Funding Trust 2019-2 (ESG Relevance Score of 5)

This rated transaction consists of 7,026 prime quality seasoned residential mortgage loans with a total balance of US\$425.9 million as of the cutoff date. The pool has an unusually low average loan-to-value ratio of 49.6%, with 94% of fixed-rate mortgages under 30 years duration, and 90% of payments made on time in the past 2 years. Despite these metrics, a number of negative factors are driving the overall elevated ESG Relevance Score of 5, indicating a direct impact on the ratings driven by Exposure to Environmental Impacts (see **Figure 4**).

Because of this pool's large concentration in the Gulf Coast region, natural disaster and catastrophe risk are far higher compared with most transactions. Approximately 43% of the pool is concentrated in Louisiana and an additional 33% in Texas, resulting in a 1.16x PD adjustment for the geographic concentration and increasing expected loss (EL) by 104 basis points (bps). This is one of the largest adjustments Fitch has made for geographic concentration.

Nearly a quarter of the pool is located in an area recently listed by federal agencies as a natural disaster area in response to Hurricane Barry in 2019. Fitch haircut property values for homes located in these areas by 10% to reflect the potential risk of property damage. Multiple studies of US Federal Emergency Management Agency natural disaster areas find a significant detrimental effect on local property values, accounting for other factors, driven by higher insurance premiums and anticipation of future damage.

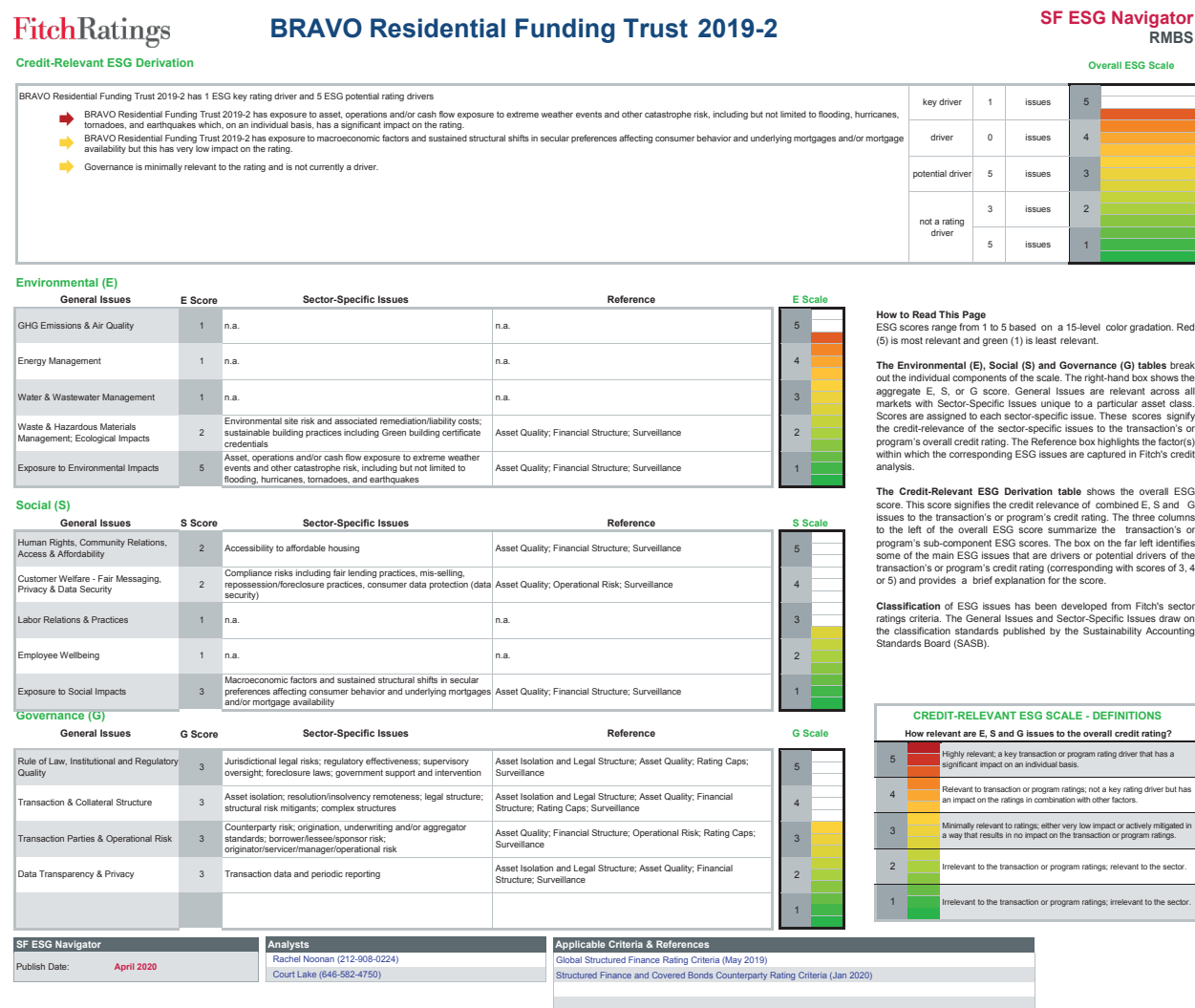
To account for potential future risk of natural disaster, the catastrophe risk adjustment added 28 bps to expected loss levels. Given the highly concentrated profile of the pool, however, we doubled the catastrophe risk adjustment to 56 bps.

Sequoia Mortgage Trust 2020-3 (ESG Relevance Score of 3)

This mortgage pool consists of very high-quality 30- and 25-year, fixed-rate, fully amortizing loans to borrowers with strong credit profiles, relatively low leverage, and large liquid reserves. It has a combined loan-to-value (CLTV) ratio of 68%. Approximately 44% of the pool is concentrated in California, with relatively low municipal concentration. The largest municipal concentration is Los Angeles (20.4%), followed by Miami (11.7%) and New York (7.2%). These areas account for nearly 40% of the pool. As a result, Fitch applied a 1.03x PD adjustment for geographic concentration.

An ESG Relevance Score of 3 for Exposure to Environmental Impacts reflects the fact that this transaction has cash flow exposure to extreme

FIGURE 4. ESG NAVIGATOR FOR BRAVO RESIDENTIAL FUNDING TRUST 2019-2 T



Source: Fitch Ratings.

weather events, such as flooding, hurricanes, tornados, and earthquakes, but this factor has minimal impact on the rating because of the characteristics already outlined (see **Figure 5**). We note some evidence of insurers withdrawing from high wildfire risk areas, such as parts of California, but in most cases, these properties would be covered by standard insurance policies.

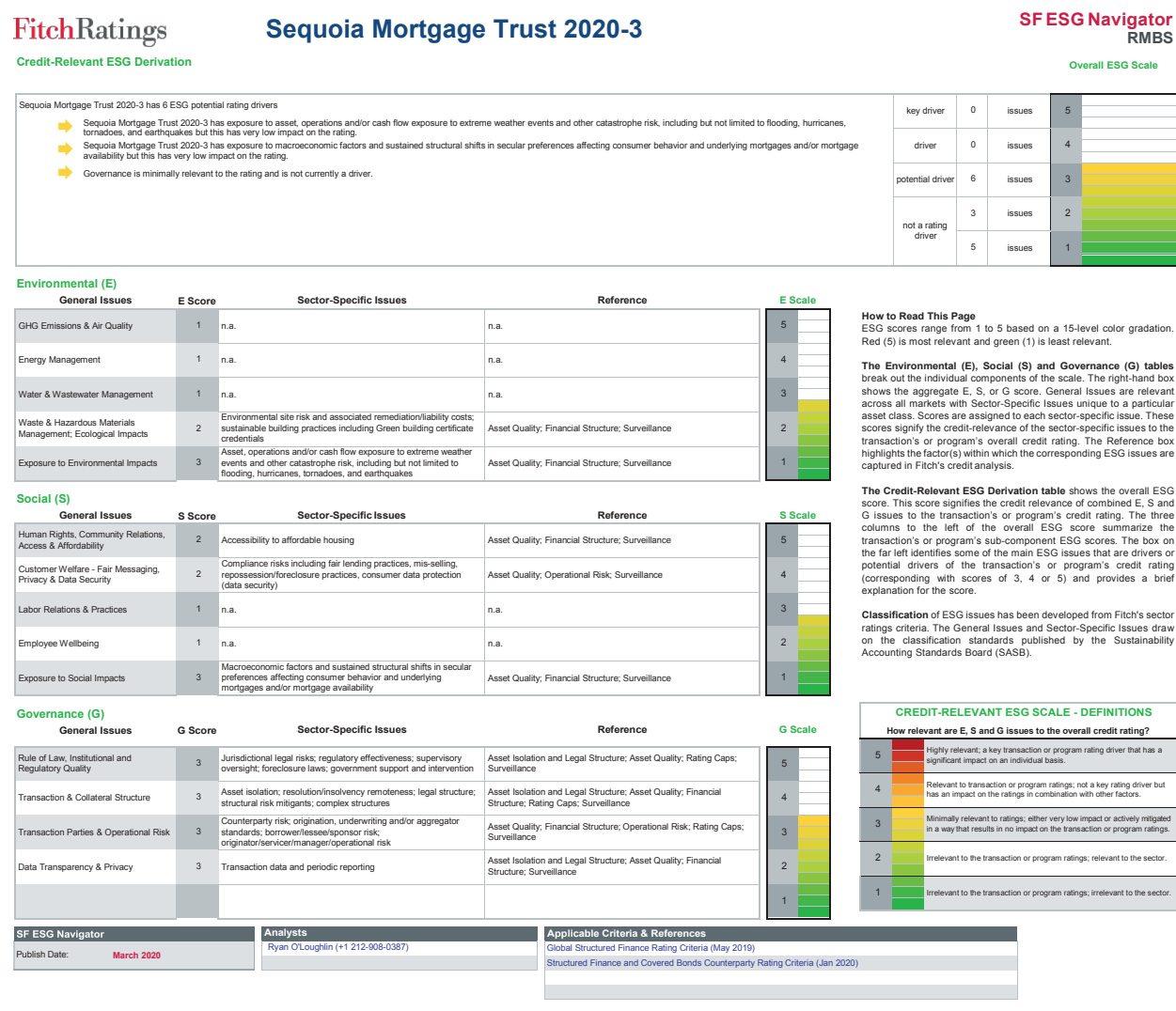
Geographical Concentration and Ratings Stress Assumptions

These examples highlight the key role of asset location and geographical concentration, together with underlying fundamentals, as key drivers of credit risk. Mortgage pools with a high geographical

concentration and a concentration in areas of heightened natural disaster risk are likely to face a double penalty in terms of expected loss/PD because of the likelihood of multiple insurance claims from multiple disasters within the area (driving up premiums and lowering property values), as well as anticipation of increased magnitude and frequency of such disasters in the future.

Nonetheless, rated transactions with high geographical concentration but strong underlying credit profiles and shorter average loan maturities will be better placed to manage these risks, as highlighted in our second example. This underlines the importance of integrating ESG factors in credit ratings research in a consistent and transparent way, while providing reasonable forward-looking assessments of these risks.

FIGURE 5. ESG NAVIGATOR FOR SEQUOIA MORTGAGE TRUST 2020-3



Source: Fitch Ratings.

More information on Fitch's ESG Research is available at: <https://www.fitchratings.com/topics/esg>.

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Climate Change Analysis in the Investment Process

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Manulife Investment Management

INDIA EQUITY: SUPPLY CHAIN OPPORTUNITIES IN A GLOBAL LOW-CARBON TRANSITION

Koushik Pal and Eric Nietsch, CFA

Manulife IM believes that ESG factors can contribute meaningfully to an investment's risk-reward profile, and we also hold that careful consideration and management of relevant ESG dynamics can lead to long-term value creation. Our India Equity team uses its extensive research network and experience to quantify the opportunities that ESG trends create for Indian companies, particularly when strong governance enables the translation of these trends into greater stakeholder value. The team evaluates these factors in its research and security selection process, portfolio construction, and active stewardship of the companies in which it invests.

The team recognizes global trends around the low-carbon transition, particularly how these trends change sentiment and regulation in different countries. As an example, we identified how the implementation of new policies in China would affect the steel manufacturing industry, with significant implications for Indian companies upstream in the supply chain. Our team saw the potential for these changes to create a market-disrupting opportunity for certain companies to increase cash flow in a way that their share price did not yet reflect.

This example highlights one of the central challenges of ESG analysis: Global issues create different challenges and opportunities in different countries, with unique and variegated outcomes across sectors and companies. These global issues include environmental and social trends, and our India Equity team draws upon regional expertise across Manulife IM's global platform and dedicated ESG resources to analyze the effects of these themes on the Indian market. They also discuss these secular shifts with experts in other regions in order to better understand the local impact of global ESG trends.

Cross-Border Implications of Climate Mitigation

Based in India, the two companies we examine here are the country's two largest producers of ultra-high-power graphite electrodes (GE), a key consumable in

the electric arc furnace (EAF) approach to steelmaking. EAFs commonly operate by melting recycled scrap metal. This process requires graphite made from a petrochemical byproduct called "needle coke," which is one of the few substances that can withstand the extreme temperatures required for this steel production method.

As the global steel industry responded to stricter anti-pollution regulation in China, EAF-based steelmaking began to increase around the world, causing a substantial increase in demand for GEs. This shift occurred at a moment when the GE industry was consolidating in India, which meant a strong trend toward better capacity utilization and pricing power.

Although these two companies controlled more than 20% of the world's GE capacity, they operated in a niche subsector with limited analyst coverage. Neither company was rated comprehensively by third-party ESG ratings providers at the time, which further created an opportunity for differentiated in-house analysis. Furthermore, awareness of both regulatory developments in China and industry dynamics upstream in India was necessary to recognize the opportunity.

The investment case resulted from multiple ESG-related dynamics coming together:

- *Regulatory change in China*—The promotion of the "Beautiful China" initiatives increased the desire for environmental regulation compliance for all businesses, which led to a focus on reducing pollution and emissions. One outcome of this shift was increased emission regulation of steel plants in 2016 and 2017, resulting in the closure of approximately 20% of China's total steel production capacity. As Chinese steel exports declined, market share shifted to other countries. The regulatory impact on the steel market changed the dynamics of how steel is produced, with an increased share moving to the EAF process, because EAF steelmaking has a much bigger share of the total industry outside China.

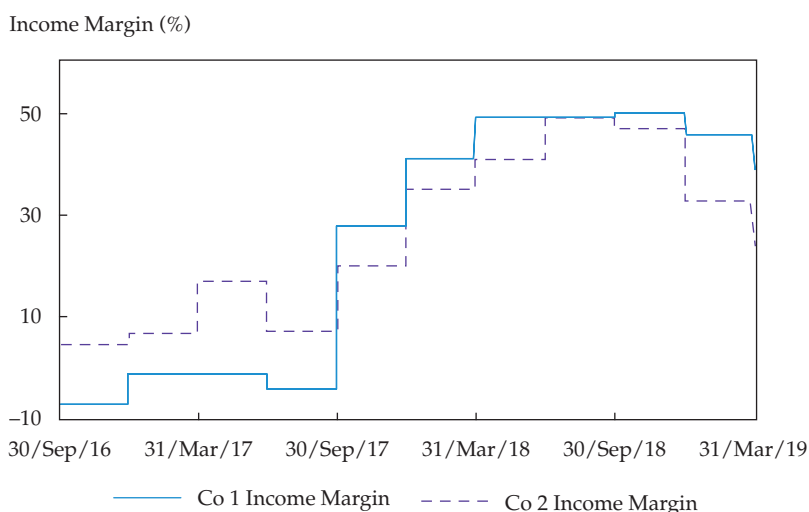
- *A less carbon-intensive steelmaking technology*—EAF steelmaking emits lower amounts of CO₂ than blast furnace processes. According to steelmaker ArcelorMittal, an EAF generates between 0.4 tonnes and 0.7 tonnes of CO₂ per tonne of steel, compared with 2.3 tonnes of CO₂ per tonne of steel made in a blast furnace. The difference is lower for high-quality steel, but it still shows improvement in emissions. Because regulatory pressures encouraging lower emissions shifted production from blast furnace steel producers in China to EAF steel producers in other countries, demand increased for the GEs used in the EAF process of steelmaking.
- *Industry consolidation*—GEs are an essential consumable for EAFs. The rise in demand for GEs came at a point of industry consolidation, resulting in shortages and a reduction in GE supply. This dynamic increased supplier power for the remaining producers, allowing them to raise prices. In this way, the change in environmental regulations in China had a transformative effect on GE suppliers in India.
- *Other low-carbon emission trends*—Another environmental dynamic that contributed to the fortunes of the GE industry was capacity expansion for production of lithium ion batteries to be used in electric cars. Battery makers were competing for the same graphite-related raw material used to make GEs—needle coke—because lithium ion batteries use graphite as the anode material. The suddenly intense competition for this raw material, in turn, meant that GE capacity

and production across the world could not be suddenly ramped up to meet higher demand from the steel industry. This additional supply constraint further increased the pricing power of the GE manufacturing subsector.

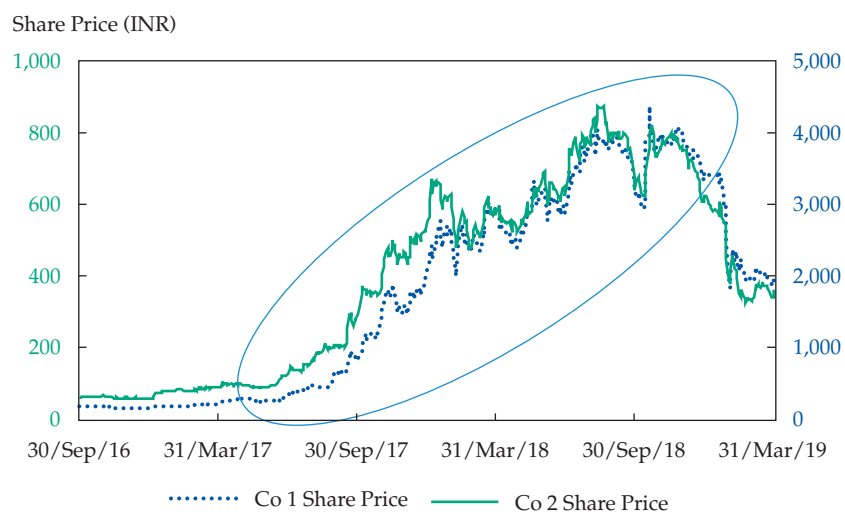
India's two GE producers had relatively thin margins in 2016 and 2017, as **Figure 1** shows. Revenues declined for both companies in these two years, with single-digit net income margins. One even had negative earnings in 2017. The increased demand and concurrent supply shortage, however, drove prices up and allowed revenue growth of more than 100% for both companies in both 2018 and 2019. Simultaneously, their net income margins expanded above 40%. Free cash flow increased more than tenfold, leading to a broad repricing of these companies as shown in **Figure 2**.

Although the opportunity appears logical in hindsight, many coordinated components needed to fall into place in order for the investment thesis to be successful. Our India Equity team observed both the global trend of climate change and the shift in environmental focus in China. They then spoke with other Manulife portfolio managers about the sentiment and political dynamics in China, as well as with others in their network about Chinese regulatory proposals, developments in the steel industry, and the management teams of companies in India. Through both research and coordination, we were able to take advantage of this cross-border supply chain opportunity.

FIGURE 1. INCOME MARGIN



Sources: Company filings and National Stock Exchange of India.

FIGURE 2. SHARE PRICE

Sources: Company filings and National Stock Exchange of India.

Conclusion

We believe that incorporating climate change, emissions, and other ESG factors into fundamental research and portfolio themes can create value for investors. When done well, this approach can reveal opportunities stemming from the interconnectedness of systemic environmental and social issues.

Although climate change represents significant risk to economic growth as well as to many companies,

changes in regulatory landscapes and industry dynamics create opportunities for some companies. The same approach can be applied with other climate-related themes, such as water scarcity, materials use, workforce trends, wellness, and longevity, among others. As our example illustrates, ESG analysis pairs well with deep fundamental research, active management, and a global platform.

Mirova

MEANINGFUL CLIMATE DATA, INTENTIONAL INVESTMENTS

Samantha Stephens

Whether they are inspired by financial materiality, active ownership, risk mitigation, regulatory risk, or a desire to create a positive impact, investors are beginning to think about climate change within their investment processes.

Looking at an asset or portfolio's direct emissions or share of climate-friendly revenues might not be enough, however, to effectively measure its exposure to climate risks and opportunities. Asset class, sector allocation, and a company's products, processes, and strategy can play decisive roles in determining its climate profile. At Mirova, we believe that methods for measuring and managing climate concerns within investments must account for these nuances.

With these variables in mind, Mirova saw the need for a method that assesses each company's products and processes in a way that is applicable and comparable across asset classes. Since 2015, we have partnered with Carbone4, a consulting firm focused on low-carbon strategy, to create a dataset that allows us to both:

- reduce climate risk by identifying the assets most likely to be exposed to climate change-related risks (namely, greenhouse gas emissions); and
- capture climate-related opportunities by creating a metric that illustrates to what extent an asset creates climate benefit through low-carbon or energy efficient products and how it might benefit from the transition to a low-carbon economy.

Financed Emissions and Emissions Savings

Two types of emissions are relatively easy to measure and have widely available data: direct emissions from fossil fuels burned on company premises (Scope 1) and emissions from electricity or heat that a company uses in the course of business (Scope 2). Because these data are so easy to access, investors looking to assess and/or improve their investments' climate profile have mainly used these types of emissions in their analyses.

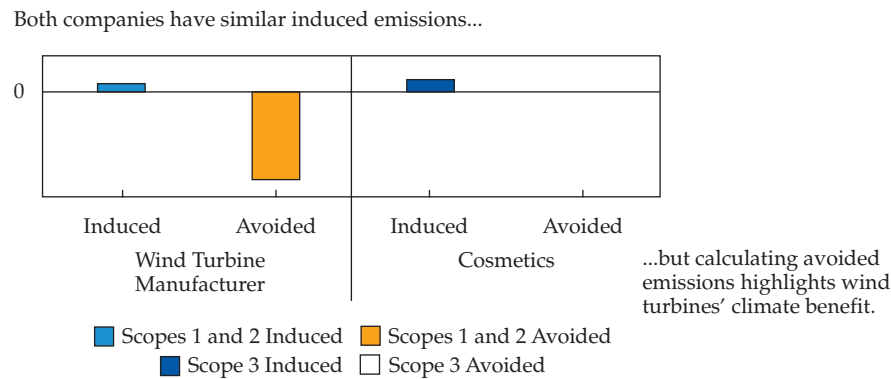
We are convinced, however, that going beyond direct emissions is essential to create meaningful

climate-friendly investment products. Accounting for raw material extraction, transportation, and final use of products is essential because these life-cycle "Scope 3" emissions dwarf Scope 1 and Scope 2 emissions in several key sectors. The use phase of an oil company or automobile manufacturer's products, for example, constitutes 80% of their carbon impacts. Ignoring Scope 3 emissions can thus obscure a portfolio's exposure to transition risks related to climate change, as well as its broader climate profile.

Our analysis has suggested that relying only on Scope 1 and Scope 2 emissions data can produce portfolios and indexes that do not live up to their climate-friendly claims. Once Scope 3 emissions are accounted for using a life-cycle approach, "low carbon" indexes based exclusively on direct and electricity emissions often have carbon footprints very similar to their traditional counterparts (i.e., those with no carbon considerations). For example, some of these indexes include a consequential share of oil majors that have made small reductions in their operational emissions without addressing the inherent incompatibility between the fight against climate change and the company's existing business model.

Induced emissions—the real emissions created by a company or asset across all three scopes—can represent exposure to climate transition risk. Emissions saved—the emissions avoided by a company's products or processes relative to a pertinent baseline—can indicate a company's or portfolio's exposure to opportunities in energy transition. Both measures are necessary—if we look only at induced emissions, two companies with similar life-cycle carbon emissions may be indistinguishable, even if one provides technological solutions instrumental for mitigating climate change and the other provides a product with low or no added value for the climate. When saved emissions are considered alongside induced emissions, the company's total contribution to climate change mitigation becomes clear. **Figure 1** illustrates the issue with an example.

Although reporting Scope 1 and Scope 2-induced emissions is relatively straightforward, considering the full life cycle of emissions (both induced and saved) can prove challenging from both philosophical and

FIGURE 1. EMISSIONS COMPARISON FOR COSMETICS COMPANY AND WIND TURBINE MANUFACTURER, 31 OCTOBER 2019

Source: Mirova/Carbone4.

analytical perspectives. Because these assessments rely on estimates, uncertainty is involved. But gaining a sense of the magnitude of a company's emissions financed versus saved can be more telling than very precise figures that fail to tell the whole story. We have shifted from disclosure-oriented to performance-oriented carbon data.

Aligning Portfolios with Climate Scenarios

Today, our partner Carbone4 provides us with a database of financed and saved emissions for each company we cover. Each company's individual carbon assessment is aggregated at the portfolio level and reprocessed to avoid double counting. Once aggregated, a portfolio's coherence with various climate scenarios is estimated on a scale from 1.5°C to 4.5°C (degrees of associated global temperature increase) using investment projections from the International Energy Agency and the Intergovernmental Panel on Climate Change.

- A 1.5°C–2°C portfolio finances a high level of solutions providers relative to emissions produced. It implies substantial policy action and mitigates the transition risk associated with an economy aligned with 2°C of warming or less by 2100 by reducing the quantity of emissions it finances. Such a portfolio captures mitigation opportunities linked to achieving this goal by investing in assets that provide products or services that reduce the economy's greenhouse gas intensity.
- A 4.5°C portfolio is in line with the continued growth of greenhouse gas emissions and limited

political action, implying severe, long-term, global climate consequences, high risk for the portfolio, and limited exposure to climate-related opportunities.

This method assesses equity portfolios and indexes without explicit climate considerations to align with a 3.5°C–4°C rise in global average surface temperature, in line with long-term emissions growth and limited policy action: the status quo scenario.⁴⁹ For example, as of 1 May 2020, we calculate the S&P 500 Index to be aligned with a 3.8°C global warming trajectory.

Although the carbon metrics and temperature indicator we have developed with Carbone4 offer a telling and concise way to communicate and monitor a portfolio's exposure to climate risks and opportunities, we believe that mitigating climate change today means mitigating an enormous and uncertain risk to investments over the long term. As such, we consider developing meaningful and robust emissions data to be a first step for investors. The second step is integrating these data into the investment process.

Using Climate Data in the Investment Process

In 2015, Mirova set a target to align all of our portfolios with a 2°C scenario based on the method we developed with Carbone4. As an example, at the outset, we assessed our consolidated equity portfolio to be in line with a status quo scenario: 3.1°C. Over time, by integrating climate change into every step of our investment process, we have reduced this level to 1.5°C.

⁴⁹Mirova, "Aligning Portfolios with the Paris Agreement" (2019).

We achieved this goal by identifying thematic investments related to climate change mitigation and adaptation and then analyzing climate risks and opportunities as an essential part of company fundamentals. We have worked to create ambitious low-carbon portfolios and indexes, and we have formally incorporated emissions data into our portfolio risk metrics. In valuation, we account for higher costs of capital for emissive companies.

There are nevertheless many other methods for incorporating climate considerations in investment processes. We believe that all have their merits, as investors who consider the full life-cycle climate performance of investments can experience less

long-term vulnerability (and potentially an information advantage relative to investors looking exclusively at operational emissions).

At Mirova, we are convinced that a comprehensive carbon measurement method that emphasizes both life-cycle-financed emissions and emissions savings is essential for managing transition risk exposure, capturing climate-related opportunities, and improving the impact of issuer engagements. We believe that by working to align assets and portfolios with a 1.5°C climate trajectory and systematically considering climate change within the investment process, investors can increase the climate resilience of their investments, their business, and the planet.

Man Numeric

CARBON BUDGETING IN QUANTITATIVE MANAGED PORTFOLIOS

Robert E. Furdak, CFA, and Jeremy Wee, CFA

ESG objectives can be implemented in quantitative portfolios through a number of different approaches. In this case study, we look at how an investment manager can meet clients' objectives of reducing the corporate carbon output using simple constraints in portfolio construction.

Although the implementation is straightforward, we caution against a simple "set and forget" approach. ESG data are unstructured, messy, and often not normally distributed. As such, practitioners should pay special attention when standard quantitative tools are applied to analyze ESG data. Specifically, we look at ways to avoid some of the pitfalls in overlaying carbon data on portfolios and how a careful implementation process can lead to portfolios that achieve the carbon objective while minimizing unintended secondary effects.

The Problem

The simplest approach to integrating a carbon objective into portfolios involves an exclusion list—that is, a list of companies that the asset owner considers "dirty." For example, one could simply create a list of heavily polluting companies and remove them from the investment universe. Although the exclusion list method is simple and transparent, it forces absolute "yes or no" decisions, which can often mask the subtleties of some corporate activities. For example, although many environmentalists criticize big oil companies for their carbon emissions, these organizations undeniably play a part in our economy today. Rather than excluding all oil companies, should we instead invest in less-carbon-intensive big oil companies that have strong policies and commitments to reduce emissions?

Another method for integrating ESG data into the quantitative investment process involves constraints in the portfolio construction process. This approach involves setting an upper bound on a chosen carbon measure on an absolute or benchmark relative

basis—for example, that the portfolio's carbon intensity (defined as a ratio of carbon emissions to revenue) must be a certain percentage better than the benchmark. Unlike the exclusion list method, the constraint-based approach does not require absolute decisions on particular securities.

Carbon Data Issues

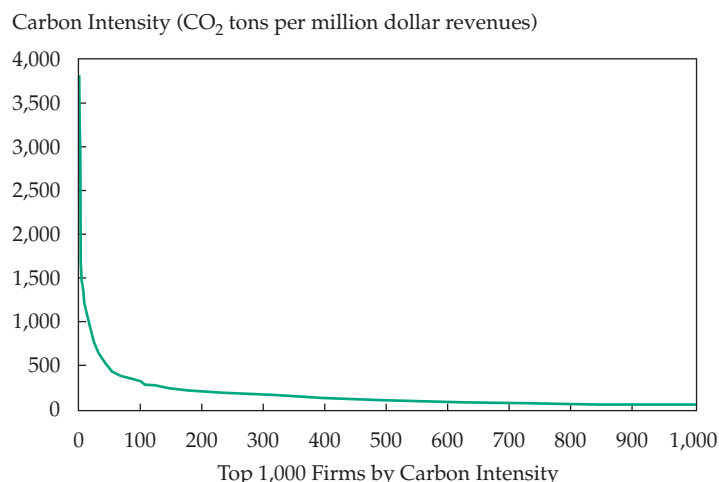
We caution that with a quantitative approach to carbon budgeting, gains in implementation simplicity can be lost in transparency. This issue is particularly acute because the distribution of carbon data is severely skewed. Skewness, although not a problem by itself, can lead to non-optimal portfolio solutions in the presence of other constraints and path dependency. **Figure 1** shows Trucost carbon intensity data as of 29 March 2019.⁵⁰ To meet a specified carbon intensity level, because of the nature of the skewed data, a portfolio manager could divest a few outsized carbon emitters (if they exist) in the portfolio or trim many positions across multiple high-carbon emitters. Depending on how other constraints are set up, the portfolio optimization process might tilt toward either the "sell down a few" solution or the "trim many" solution.

Figure 2 illustrates a scenario in which the portfolio manager trades off signal exposure with the constraint (or desired exposure) level. When the constraint level is tightened, signal exposure (expected excess return) should fall. A byproduct of tighter constraints is increasing deviation from the optimal portfolio. The holding's overlap with the optimal portfolio decreases with more-stringent constraints. A benefit of carbon constraints is the ability to achieve meaningful reductions of carbon emissions in one's investment portfolio (between 30%–40%) without significantly impacting returns. If the data are skewed, however, a portfolio manager will have to choose among multiple paths to achieving a desired exposure that may not all have equivalent signal exposure.⁵¹

⁵⁰Trucost carbon intensity is measured in carbon emissions per millions of US dollars in revenue.

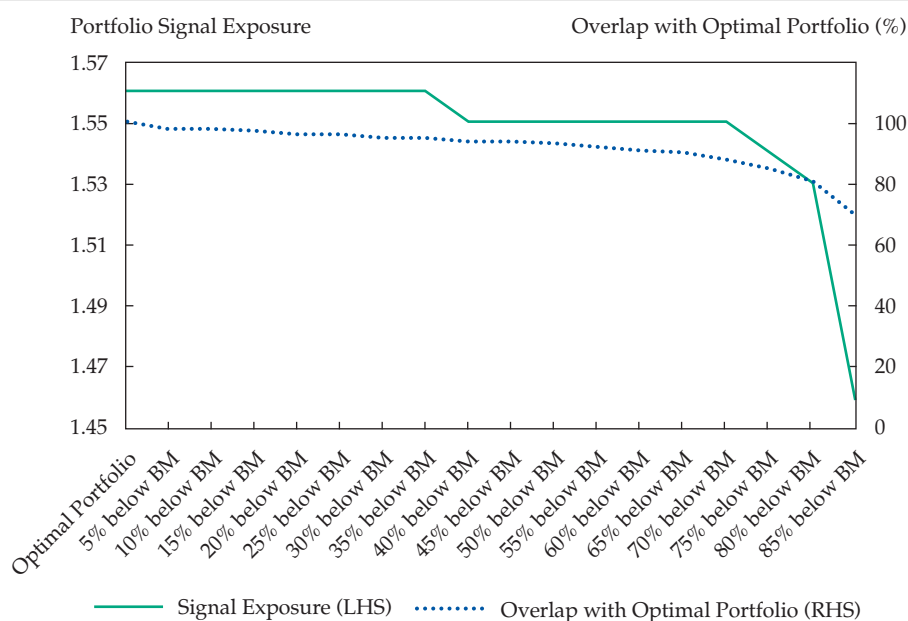
⁵¹The simulated model results shown in Figure 2 have certain inherent limitations. Unlike an actual portfolio record, simulated results do not represent actual trading. Also, because the trades have not actually been executed, the published results may have under- or overcompensated for the impact, if any, of certain market factors, such as lack of liquidity. In addition, simulated trading programs in general are designed with the benefit of hindsight. There exist limitations inherent with model results. Results include simulated transaction costs but do not include the impact of actual trading.

FIGURE 1. TRUCOST CARBON INTENSITY DATA DISTRIBUTION, 29 MARCH 2019



Source: S&P Trucost Limited.⁵²

FIGURE 2. SIMULATED IMPACT OF CONSTRAINTS ON PORTFOLIO SIGNAL EXPOSURE AND HOLDINGS



Sources: Man Numeric and Trucost.

The Solution: Systematic Portfolio Construction

The measure of carbon emissions on a carbon-restricted mandate varies based on client preference. Some prefer an absolute measure of carbon emissions (e.g., tons of CO₂ emitted from all companies in the overall portfolio), whereas others prefer a relative

measure (e.g., carbon intensity or tons of CO₂ emitted divided by revenue relative to benchmark). We think it may be useful to use a measure that includes both Scope 1 and Scope 2 emissions—that is, the company’s own direct emissions from sources it controls, as well as indirect sources, such as purchased electricity, heat, or steam.

⁵²All rights in the Trucost data vest in Trucost and/or its licensors. No further distribution of the Trucost data is permitted without Trucost’s express written consent. Trucost accepts no liability for any errors or omissions in the Trucost data.

Carbon data can be applied as a budget or constraint in a systematic portfolio construction process that maximizes portfolio exposure to stock selection models. By applying the constraint systematically, a portfolio manager can ensure that the portfolio will meet the targeted carbon level. Moreover, a risk model can be integrated into this step. This risk model should be dynamic and automatically adapt to emergent market themes. For the purpose of the additional carbon constraint, such a risk model would add an additional perspective to manage the risks arising from the carbon budget.

For most of these strategies, the ESG profile would be further augmented by including a proprietary ESG model in a similar manner to integrating other models, such as value or momentum, in a multi-model context.

Results

In evaluating any quantitative approach to carbon budgeting, one should pay special attention to how the addition of the carbon constraint affects the portfolio's risk and return profile.

From our experience, we believe it is possible to maintain similar industry/factor/model exposures to non-carbon-constrained strategies for a carbon budget of up to 30% to 40% below the benchmark.

We conducted this analysis using Man Numeric stock models and portfolio construction techniques on the MSCI Global Developed Markets universe. Some key observations include the following:

- 1) **No meaningful sector tilts.** Our research indicates that for mandates with carbon budget requirements, managers are for the most part able to maintain tight ($\pm 5\%$) industry bounds relative to the benchmark. As one lowers the carbon budget, the portfolio begins to tilt away from carbon-intensive industries. We note, however, that for budgets up to 30% to 40% below the benchmark, industry bounds of up to $\pm 5\%$ relative to benchmark are easily achievable because of the skewed carbon data.

Table 1 shows the distribution of the carbon intensity Scope 1 and 2 data provided by Trucost. In the high-carbon-intensive Energy and Materials sectors, although the median carbon intensity Scope 1 and 2 value is high, its distribution is wide. For example, the 5th and 10th percentile values in these sectors are significantly lower than the median values, which allows for easy substitution within the sector. The most carbon intensive sector in the MSCI World Index is the Utilities sector. We note, however, that this sector

**TABLE 1. MSCI GLOBAL DEVELOPED UNIVERSE, CARBON INTENSITY, 29 NOVEMBER 2019
(CO₂ TON PER US\$ MILLION IN REVENUE, SCOPE 1 AND 2 EMISSIONS)**

	5th Percentile	10th Percentile	Median	90th Percentile	95th Percentile
Energy	83	135	357	551	1,184
Materials	32	49	713	4,183	5,237
Industrials	9	11	54	672	875
Consumer discretionary	12	13	24	46	56
Consumer staples	44	49	79	256	265
Health care	2	4	16	51	59
Financials	1	1	7	20	33
IT	6	9	17	120	159
Communication Services	14	18	29	53	66
Utilities	1,065	1,152	2,024	8,264	9,594
Real estate	5	8	77	241	328

Sources: MSCI, Trucost.

TABLE 2. SIMULATED PORTFOLIOS AT VARYING CARBON BUDGETS, 29 NOVEMBER 2019

	Portfolio Weight				Carbon Intensity Contribution (Weight × CO ₂ tons per US\$ million revenues)			
	No	5%	10%	20%	No	5%	10%	20%
	Constraint	Reduction	Reduction	Reduction	Constraint	Reduction	Reduction	Reduction
Energy	3.6%	3.7%	3.7%	3.7%	14.5	14.0	14.0	14.0
Materials	3.4%	3.1%	2.9%	2.9%	89.1	72.4	63.5	53.0
Industrials	10.6%	10.6%	10.6%	10.6%	13.6	12.5	11.6	10.4
Consumer discretionary	8.9%	9.1%	9.3%	9.4%	2.5	2.5	2.6	2.7
Consumer staples	7.4%	7.7%	7.8%	7.8%	6.9	7.2	7.3	7.2
Health care	14.3%	14.3%	14.3%	14.3%	2.7	2.7	2.7	2.7
Financials	16.2%	16.1%	16.2%	16.2%	1.3	1.3	1.3	1.3
Information technology	18.3%	18.6%	18.6%	18.6%	6.2	6.2	6.2	6.2
Communication services	10.4%	10.4%	10.4%	10.4%	3.5	3.5	3.5	3.5
Utilities	4.1%	3.4%	3.3%	3.0%	119.2	75.3	74.1	64.0
Real estate	1.9%	2.1%	2.1%	2.2%	2.1	2.1	2.0	2.1
Total	99.1%	99.1%	99.1%	99.2%	261.5	199.7	188.8	167.0

Source: Man Numeric.

has only a 3.4% weight (as of 29 November 2019) in the MSCI World Index.

- 2) **No noticeable impact on performance.** In the simulation studies we ran, we found that it is possible to generate portfolios with carbon budgets of up to 30%–40% below benchmark with no meaningful impact on performance. For most quantitative managers, the investable universe is broad and varied enough to offer liquid substitutes in place of high-carbon-intensive names. To limit adverse selection and risk biases in the portfolio, we believe it is important to have a rigorous tool kit for removing unwanted risks and tilts.

For example, the 20% carbon reduction simulation portfolio has a 97% holdings overlap and 99.8% return correlation with the no-budget portfolio. With such a high overlap and return correlation, the two portfolios' performance does not deviate significantly over time, and we see no meaningful difference in *ex post* risk–return characteristics.

Yet another measure of portfolio efficiency is "alpha exposure," which can be thought of as the weighted average exposure of the portfolio to quantitative signals. In a perfect world, alpha exposure can also loosely be thought of as a unit of measure proportional to excess return. At 20% carbon reduction, alpha exposure does not deteriorate, which means that managers were able to find equivalent high-model-ranked names as substitutes.

Table 2 shows the sector breakdown by weight and carbon intensity contribution for various simulated portfolios. Note that although the weight in Energy, Materials, and Utilities is low in these portfolios, these sectors constitute the majority of the carbon budget. In sectors with lower carbon intensity, the portfolio composition is mostly unchanged at various carbon budget levels, which consequently leads to high portfolio overlap and high performance correlation.⁵³

⁵³This table contains hypothetical or simulated model results that have certain inherent limitations. Unlike an actual portfolio record, simulated results do not represent actual trading. Also, because the trades have not actually been executed, the published results may have under- or

- 3) **No significant style drift.** We also note that in the simulation studies we ran, we find no significant style drift for carbon budgets up to 30%–40% below benchmark. We measure style using the Barra Global Total Market Equity Model for Long-Term Investors (Barra GEM LT) model. Exposures to such factors as value, quality, and volatility essentially stay unchanged for all the simulated scenarios.

Conclusion

Our research shows that the best way to reduce the carbon intensity of a portfolio is quantitatively, using a constraint in portfolio optimization. The skewed nature of corporate carbon emissions means a manager can create a significantly greener portfolio (in the range of 30%–40%) without a material impact on investment signal, risk exposures, or return.

overcompensated for the impact, if any, of certain market factors, such as lack of liquidity. In addition, simulated trading programs in general are designed with the benefit of hindsight. There exist limitations inherent with model results. Results include simulated transaction costs but do not include the impact of actual trading.

CLIMATE CHANGE: A NEW DRIVING FORCE FOR ENGAGEMENT

Christopher Greenwald and Valeria Piani

Climate change represents one of the most significant long-term risks that investors face in the coming decades, and consequently, any integration of climate change issues in financial analysis must be supported by a robust strategy for corporate engagement. Indeed, effective engagement is well suited to equity investments across both active and passive strategies. This approach not only provides a mechanism for deeper insights into climate change risks for company performance but also provides a mechanism for mitigating those risks through corporate action.

For active strategies, engagement can inform our forward-looking fundamental understanding of how a company's management is addressing climate change in its strategy and risk management systems. For passive investments, corporate dialogue can address large negative externalities that impact the environment, the wider economy, and thereby index returns in the long term. At UBS Asset Management (UBS AM), we believe that to be successful, a climate engagement strategy must be focused, oriented around a material framework relevant for both companies and investors, and collaborative in nature in order to maximize effectiveness and realize positive change.

First, given that effective corporate engagement requires a great deal of dialogue with management to create change over time, it is important to prioritize any engagement strategy by focusing on the most relevant companies in terms of risks and opportunities. Our strategic engagement program on climate has focused on the oil & gas and utilities sectors, given their significant contribution to global CO₂ emissions. Within these two sectors, we selected 50 companies by screening FTSE Developed World Index components using our proprietary "Climate Aware" methodology. This approach uses both quantitative and qualitative data in a forward-looking assessment of future climate change risks. The resulting set of 50 companies represents 27% of the direct and indirect CO₂ emissions of the FTSE World Index as a whole, allowing our engagements to have the greatest impact in terms of mitigating environmental risks. In selecting

our focus list, we also considered feedback from our fundamental sector analysts, who helped us identify the companies most receptive to dialogue.

Second, to create the most effective engagements, we oriented our engagement goals around a framework that is both financially material and well understood by corporate management teams. Consequently, we defined our objectives around the TCFD, an internationally recognized framework for both companies and investors to assess the impact of climate change on business strategy and to report on these impacts in traditional financial disclosures. We then conducted a detailed scorecard analysis for each company in order to identify the most relevant areas of potential improvement, focusing on the core elements of the TCFD:

- Governance of climate change
- Risk management
- Strategy and policy
- Metrics and performance
- Targets
- Lobbying activities
- Overall level of disclosure

Conducting this scorecard analysis prior to our first dialogue with management was key for identifying any existing gaps in corporate performance and thereby formulating the most relevant climate engagement goals. Most importantly, it allowed us to formulate goals linked to each company's business model and geographic footprint. By using a public framework that is familiar to companies in carbon-intensive sectors, we created engagement goals that are both relevant for senior management and thereby more likely to have an impact on company action as well as corporate disclosure of climate-related risks.

Third, to maximize both the coherence and effectiveness of our engagements, we aligned our climate engagement strategy through collaboration with other asset owners and asset managers. Specifically, UBS AM is currently participating in 29 coalitions of investors within the investor initiative

Climate Action 100+ (CA100+)⁵⁴, leading 8 of these groups across regions. Collaborating with other investors does not necessarily help to increase corporate access—in our experience, companies are generally happy to engage with us. Rather, collaborative engagement offers an opportunity to ensure that companies receive a single, consistent message from a number of the world's largest investors. This consistency allows companies to focus on addressing the core issues linked to climate change rather than needing to reconcile divergent investor requests. Collaboration also allows investors to share various perspectives while combining expertise in order to better challenge and support corporate representatives in setting ambitious actions.

During the past two years, UBS AM has engaged with all of the companies in our climate focus list and held approximately 150 meetings, primarily with board members and heads of sustainability. The following example highlights our engagement results with Equinor, a Norwegian energy company that has been highly responsive to dialogue.

Case Study

Our Climate Aware methodology flagged Equinor because of carbon emissions trends and fossil fuel exposure. The company also came to our attention in February 2017 as one of the world's top 100 GHG emitters included in the engagement focus of CA100+. Its stock has been attractive for active strategies because of the company's exposure to large oil fields compared with other integrated majors, the transition from being a marginal to a low-cost producer and its increasing investments in renewables, other low-carbon technologies and emission management solutions. We began our dialogue with Equinor, in collaboration with two other CA100+ investment managers, by focusing on the strategic engagement objectives emerging from our TCFD-based analysis.

Following a series of productive meetings with senior management, in 2019 Equinor issued a joint statement⁵⁵ with UBS AM and the other CA100+ co-leads, committing the company to pursuing

a business strategy consistent with the goals of the Paris Agreement. Equinor agreed to assess its portfolio, including new material capital expenditure investments, in relation to a "well below 2D [2°C] scenario" from 2020 onwards. The company also committed to reviewing existing climate-related targets up to 2030 and set out new ambitions beyond 2030 for its business activities, informed by its assessment, stress testing, and business strategy.

These strategic commitments were followed by additional dialogue with the company during the past year. As part of these efforts, in February 2020, Equinor subsequently announced additional, more ambitious climate change goals, including the following:

- Carbon neutrality of global operations (operated) by 2030—including Scope 1 and 2 emissions);
- <8 kg per barrel of oil equivalent (boe) CO₂ intensity by 2025—including Scope 1 and 2 emissions);
- A 40% reduction in absolute GHG emissions in Norway by 2030, 70% by 2040, and near 0 absolute GHG emissions in Norway by 2050 (including Scope 1 and 2 emissions with no offsetting);
- Growing renewable energy capacity tenfold by 2026, and 30 times by 2035, becoming a global offshore wind major; and
- Reducing net carbon intensity/net energy production at least 50% by 2050. This indicator includes Scope 1 and 2 (100% operated) and Scope 3 emissions (equity production) estimated based on regional refinery yields.

We acknowledge and welcome the company's willingness to issue concrete and public ambitions on renewable energy, net-zero emissions (Scope 1 and 2), and carbon intensity, including Scope 3 emissions (for the first time). Looking ahead, we will focus our dialogue on possible ambitions to achieve net-zero emissions by 2050 across the entire value chain. Ultimately, we believe that in just two years, our engagement, collaboratively with other asset managers under the CA100+ umbrella, has been successful in realizing change through targeted, materially relevant engagement goals linked to the TCFD.

⁵⁴More information on this initiative is available at <http://www.climateaction100.org/>.

⁵⁵The statement is available at <https://www.equinor.com/en/news/2019-04-24-climate-action-100plus.html>.

SUGGESTED READING

Please visit <https://www.cfainstitute.org/research> for updates and additions.

This list of recent research on the topic of climate change is by no means exhaustive. We hope that this list of climate-related resources helps investors better understand the research and investing landscape around climate change and can direct them to still further resources referenced in many of these reports.

[Assessing Climate-Related Risks in the Global Meat Industry](#), FAIRR Initiative, 2020—The global meat industry is increasingly vulnerable to the severe material risks posed by climate change, and this report introduces a tool to help investors quantify the implications of those risks. Based on TCFD-linked scenario analysis, the tool explores the potential downside risks and upside opportunities related to animal protein companies if the global temperature rises by 2° Celsius. Today's markets have not priced in the physical and transition risks within the meat sector, and investors need high-quality insights into how climate-related risks and opportunities will evolve across this industry in an era of extreme disruption.

[The Case for an Economy-Wide Carbon Fee](#), Climate Leadership Council, 2019—This report examines the gap between nominal and effective carbon prices in many jurisdictions, revealing that the many exemptions and carve-outs result in an effective carbon price that often blunts the intended effectiveness of carbon pricing schemes. To make carbon pricing more effective, governments should implement a truly economy-wide price on CO₂ emissions by including all sectors and eliminating special treatment of high-emitting industries. But governments will do so only if they can overcome legitimate concerns about competitiveness and carbon leakage. The best policy mechanism for effective carbon pricing is a border carbon adjustment (BCA) that levels the economic playing field and encourages other jurisdictions to adopt similar carbon pricing approaches.

[Climate Risk and Response: Physical Hazards and Socioeconomic Impacts](#), McKinsey Global Institute, 2020—This report examines how the earth's changing climate could affect socioeconomic systems around the world in the next three decades. It explores seven major characteristics of physical risk from a changing climate, which are already underway. The global socioeconomic impacts will be substantial and nonlinear, and countries with lower per-capita GDP are most exposed to climate change risks.

[Climate-Savvy OFS: Pilot Project Report for OPTrust](#), Ortec Finance, 2018—This report offers an excellent summary of the physical risks posed by climate change. The authors model a number of different global warming pathways based on temperature increases and policy response, examining the ramifications of each different scenario.

[Emerging Markets Outlook 2019: Energy Transition in the World's Fastest Growing Economies](#), BloombergNEF, 2019—The report examines the current state of energy transition in emerging markets around the world.

[The European Green Deal](#), European Commission, 2019—This report details the provisions of the European Union's initiatives dedicated to mitigating climate change.

[Existential Climate-Related Security Risk: A Scenario Approach](#), Breakthrough – National Centre for Climate Restoration, 2019—This report analyzes several climate change scenarios. It finds that because climate change currently represents a near- to mid-term existential threat to human civilization, a new approach to climate-related security risk management is required to avert this threat. The analysis gives particular attention to the high-end risks and difficult-to-quantify "fat-tail" possibilities.

[How to Improve Climate-Related Reporting](#), European Financial Reporting Advisory Group, 2020—This report was prepared to support practical applications for European corporate reporting stakeholders. It focuses primarily on identifying good reporting practices and assessing the level of maturity in implementing the TCFD recommendations, while also considering the climate-related reporting elements of the EU Non-financial Reporting Directive and the related European Commission non-binding guidelines. The project addresses two areas: a general review of climate-related disclosures and an in-depth review of the scenario analysis.

[IFRS Standards and Climate-Related Disclosures](#), IFRS Foundation, 2019—This report provides a resource to investors and accounting professionals that helps them understand existing requirements concerning climate change in the current International Financial Reporting Standards (IFRS) as well as guidance on the application of materiality. Although climate change risks and other emerging risks are not covered explicitly by the IFRS Standards, the Standards do address issues that relate to them.

[Investing in Carbon Efficient Equities: How the Race to Slow Climate Change May Affect Stock Performance](#), Credit Suisse Group, 2015—This report uses scenario-based modeling analysis to explore how climate change policies and technology developments can affect investment returns.

[Getting Physical: Scenario Analysis for Assessing Climate-Related Risks](#), BlackRock Investment Institute, 2019—This report explores how physical climate-related risks vary by region across the United States. The authors also use scenario analysis to look at creditworthiness of state and local municipal bond issuers, commercial real estate, and the electric utility industry.

[The Green Swan: Central Banking and Financial Stability in the Age of Climate Change](#), Bank for International Settlements, 2020—This report examines the potential role that central banks can and should play in order to help countries address climate change.

[Major Risk or Rosy Opportunity: Are Companies Ready for Climate Change?](#), CDP, 2018—This report summarizes the disclosures of companies reporting to CDP on their climate-related data. The report analyzes how companies are preparing for climate-related risks and opportunities.

[Navigating Climate Scenario Analysis: A Guide for Institutional Investors](#), The Institutional Investors Group on Climate Change, 2019—This guide aims to help close the knowledge gap on scenario analysis around the issue of climate change. It presents a five-step framework to help asset owners and managers use scenario analysis.

[Regulatory Risk Amid Global Emissions Gap](#), Fitch Ratings, 2019—This report looks at the risk of potential regulation that markets may impose in order to meet promises to limit carbon emissions in the future. The report finds that the effectiveness of carbon pricing schemes in reducing CO₂ emissions is limited because of the low overall adoption of such schemes.

[Report of the High-Level Commission on Carbon Prices](#), Carbon Pricing Leadership Coalition, 2017—Countries may choose different instruments to implement climate policy, depending on national and local

circumstances and on the support they receive. Based on industry and policy experience, as well as the literature reviewed, the Commission concludes that the explicit carbon price level consistent with achieving the Paris temperature target is at least US\$40–US\$80/tCO₂ by 2020 and US\$50–US\$100/tCO₂ by 2030, assuming a supportive policy environment.

[Resilience: Global Utilities in the Time of Coronavirus, Oil Crisis, and Climate Change](#), Wells Fargo, 2020—This report explores how climate risks affect the fundamentals of utilities and how companies with climate-aware strategies can pursue a competitive advantage.

[Risky Business: The Climate and the Macroeconomy](#), J.P. Morgan Economic Research, 2020—This report paints a stark picture of the current challenges humanity faces from climate change, analyzing many of the macroeconomic studies dedicated to the effects of climate change.

[The State of Climate Risk Disclosure: A Survey of US Companies](#), Donnelly Financial Solutions, 2019—This report, created in partnership with the Society for Corporate Governance, surveys the Society members (corporate secretaries and governance professionals) to explore how US companies are addressing climate change-related disclosures.

[Climate Science Special Report](#), U.S. Global Change Research Program, 2017—The Climate Science Special Report (CSSR) is designed to be an authoritative assessment of the science of climate change, with a focus on the United States, to serve as the foundation for efforts to assess climate-related risks and inform decision making about responses. In accordance with this purpose, it does not include an assessment of literature on climate change mitigation, adaptation, economic valuation, or societal responses, nor does it include policy recommendations.

[Wells, Wires, and Wheels](#), BNP Paribas, 2019—The report explores the transition risk facing the oil and gas industry as a result of the continued growth of solar and wind energy, which will drive the nascent electric vehicle industry projected to make up half of the global fleet of cars by 2035.

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