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INSIGHTS

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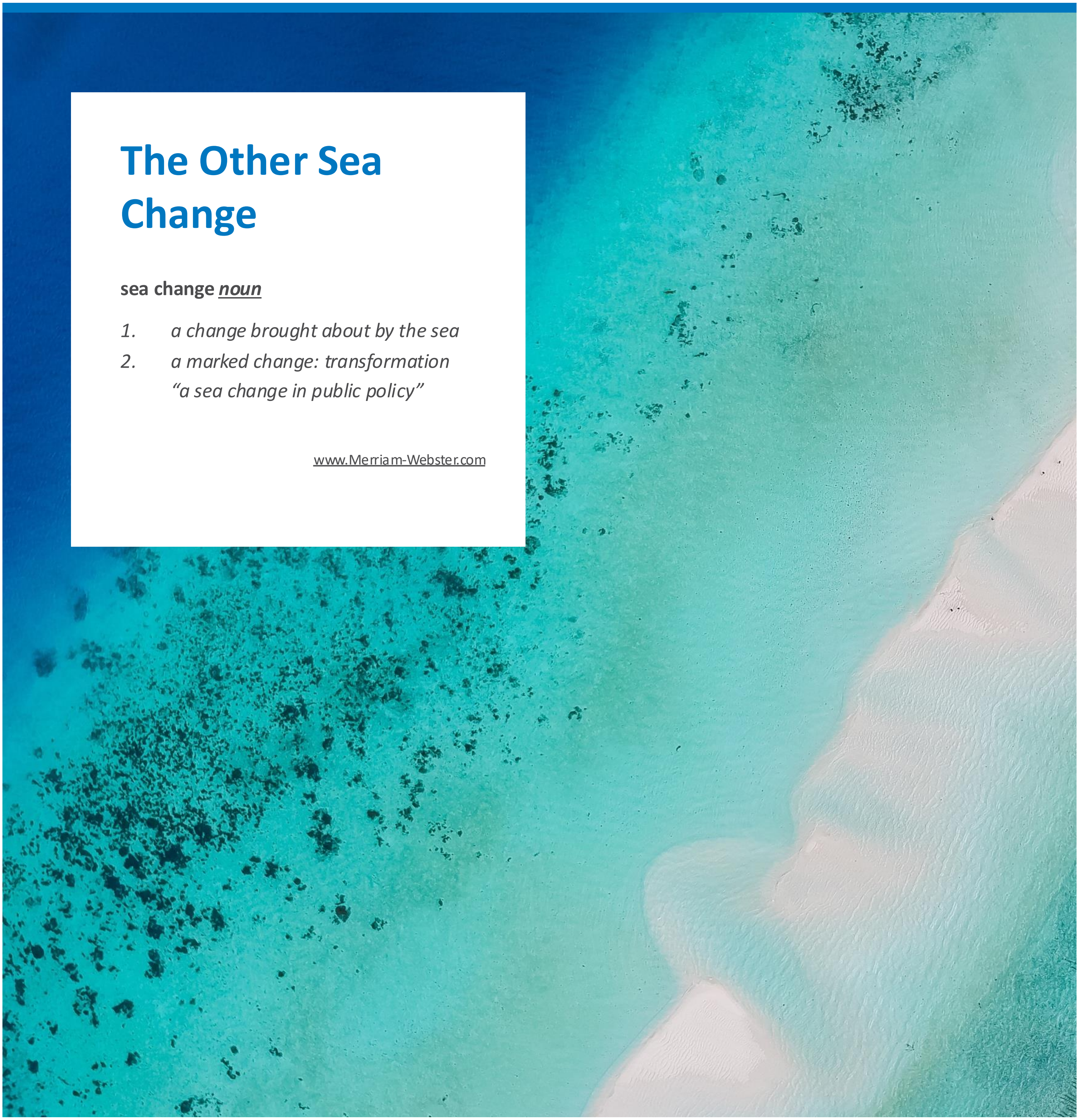


The Other Sea Change

sea change *noun*

1. *a change brought about by the sea*
2. *a marked change: transformation*
   "a sea change in public policy"

www.Merriam-Webster.com

Memo to: Investcorp Clients & Partners
From: James Socas, Head of Investcorp Climate Solutions
Re: The Other Sea Change

In December 2022, the erudite investor and commentator, Howard Marks, wrote a memorandum called "Sea Change" [1] in which he described what he believed would be the oncoming third massive shift in the financial markets during his fifty-three-year career. He argued, and I think he's right, that the era of steadily declining interest rates, which began in 1980 shortly after Paul Volcker's appointment as Fed Chair when interest rates were at 20%[2], had not only transformed finance (by enabling debt-reliant strategies like M&A consolidations and buyout), but also juiced returns through falling borrowing costs and discount rates. As a result, many people received more credit than deserved for being "smart investors" when they were riding a rising tide.

That easy money period had ended, Marks wrote, and in the new era of relatively stable interest rates many of the former strategies and tactics would no longer pay off in the same way. This was a sea change – **"a sweeping alteration of the investment environment, calling for significant capital reallocation."** It's a wonderful essay, well-argued and convincing.

However, I believe there is a bigger transformation underway. A "sea change" described by the first definition of the term: "a change brought about by the sea." And this transformation will be more impactful than shifting interest rates and will create more winners and losers than the digital revolution.

The sweeping transformations wrought by warming and climate change will be the most important and profound investment shift of the next several decades, posing enormous opportunity for well positioned investments and enormous risk to holdings on the wrong side of climate trends.

The sea is one of the places where the transformation is most apparent.

- Oceans cover two–thirds of the planet and as water can store more heat than air, and oceans are deep, the sea takes a long time to change temperature (as anyone who stepped from hot sand into cool ocean water this summer experienced). Oceans have absorbed more than 90% of the increased heat associated with emissions from human activity ("anthropogenic emissions"). [3]
- Oceans may be reaching their saturation point as water temperatures are now regularly hitting new highs. The most recent sea surface temperature average[4] for July 2024 was the second-highest measured for the month, barely missing extending the fifteenth months in a row when average sea surface temperature was the warmest recorded.[5]
- As ocean water warms, it expands and melts sea ice and glaciers adding freshwater to the ocean; less ice, in turn, leads to warmer water in a feedback loop. Sea level rise is accelerating, and in 2022, global average sea level set a new record high — 101.2 mm (4 inches) above 1993 levels.[6]
- Warmer ocean temperatures are intensifying storms and creating more hurricanes; higher sea levels worsen storm surges. In the United States, almost 40% of the population lives in coastal counties[7] and globally, eight of the world's 10 largest cities are near a coast.[8]
- Storm damage, high winds, and flooding are spiking insurance rates in exposed areas (e.g., Florida and California) and leading insurers to exit markets.[9]
- Warmer ocean waters are also driving humidity and pushing up the "heat index" – the temperature effect on the human body when relative humidity is combined with the air temperature. This summer the Persian Gulf's water temperatures – the warmest seawater in the world currently at around 95°F (35°C)[10] – and consequent humidity pushed the heat index in Gulf cities like Dubai above 140°F (60°C); a heat index of 103°F or higher is dangerous.
- As the ocean takes a long time to warm, it also takes a long time to change course and cool – its "thermal inertia."[11] Scientists estimate some of the changes of the warming ocean are already irreversible, such as the loss of coral reefs and associated marine biodiversity.[12]

While climate change is receiving more investor attention, and energy transition investments have notably increased, climate is still not given as prominent a seat at the table as it deserves. It is often discussed as one of three priorities of "ESG" or as one of several objectives of "sustainable" or "responsible" business. As a lower priority, bottom of the agenda item, few firms have modelled what their business or portfolio would or should look like in a world of much higher sustained levels of global warming, the way they might model the implications of sustained higher inflation, political realignment, or the impact of AI.

As a result, many investors are significantly underweighting climate change as a near-term, driving factor across the totality of their assets, portfolios, strategies, and returns models.

Consider just a few of the implications of what a 1.5°+ (2.7°F) or 2°C+ (3.6°F) warmer world will look like.[13]

- Major industries that were once suitable to a region or country will need to move (e.g., farming, fishing, tourism), and heat and humidity will make some places unlivable.
- Emissions-intensive processes, products and services will be significantly limited or shut down completely.
- Consumers and businesses will be forced to adjust to heat and extreme weather (e.g., in housing choices, working hours, and rising costs).
- Infrastructure, services and products built for historically predictable ranges of rainfall, wind and temperature will be strained, intermittent or inoperable.
- The largest economic sectors – real estate, finance, insurance, and energy – will undergo a massive transformation in a very short period, creating new winners and losers.

These impacts may seem improbable or a long way off, but the critical hard numbers – namely the carbon budget and annual global emissions – show that in the near term crossing the 1.5°C of warming threshold is a virtual certainty. The numbers also strongly imply that warming of 2.0°C or more is likely.[14]

While there could be a change in the trends, the odds are low due to the lack of political consensus at the national and international levels to execute change, the sheer magnitude of the required energy transition and across-the-board decarbonization work, and the substantial sunk costs supporting the status quo.

The high degree of certainty implied by the climate data calls for a "significant capital reallocation." Legacy investments will need to be evaluated, repositioned or sold based on the risks of physical property loss, demand destruction, or stranded assets. New climate-aligned investments and "adaptation" spending will enjoy accelerating tailwinds from market demand and what will be highly supportive government policies.

The Carbon Budget

The "carbon budget" is the amount of CO_2 that scientists estimate can be emitted before crossing a specific global average temperature. Because atmospheric CO_2 is the primary regulator of Earth's temperature and stays in the atmosphere for so long, global temperature rises in a near linear correlation to rising emissions.[15,16] Therefore, to keep global warming below a specified temperature level – i.e., the Paris Agreement's 1.5°C or 2.0°C limits – scientists can estimate the total amount of CO_2 that can be emitted.

The carbon budget is not time based. Just like a bank balance that can be spent quickly or drawn down over a long period, it does not matter when the budget runs out. If it is 2027, 2041, 2050 or later, the effect is the same: temperature will rise until it reaches the new CO_2 equilibrium level.[17] Just like an oven warming to a new setting, once the carbon budget is exhausted, it is a relatively short time before warming reaches that point – a median estimated to be about ten years.[18]

It is worth taking a minute to look at the detailed numbers.

In its most recent synthesis report issued in 2023, the IPCC[19] (Intergovernmental Panel on Climate Change) estimated that to keep the global average temperature below the 1.5°C threshold at a 50% probability of success (the odds of a coin flip), the amount left in the carbon budget – the "remaining carbon budget" – was 500 billion metric tons (expressed as 500 $GtCO_2$)[20] of emissions. At a 67% probability level of success the value was 400 $GtCO_2$, and for an 83% probability of success it was 300 $GtCO_2$.[21]

To stay under 2.0°C, the IPCC estimated the remaining carbon budget to be 1,350 $GtCO_2$ at a 50% probability level, 1,150 $GtCO_2$ at a 67% probability level, and 900 $GtCO_2$ at an 83% probability level.[22]

One of the biggest assumptions in these figures is that "non-CO_2 warming" remains at a low level.[23] Non-CO_2 warming refers to the net effect of (i) other greenhouse gases – methane, nitrous oxide and fluorinated gases – which add to warming, and (ii) atmospheric aerosols which shield solar radiation. However, other greenhouse gases have been rising and aerosol shielding is declining (due to more stringent regulation of fluorocarbons and sulfur dioxide pollution).[24] The rising level of methane is particularly problematic given its high warming impact[25], and the current atmospheric concentration of methane at around 1,930 parts per billion is more than 160% higher than the pre-industrial level.[26] The IPCC estimated that factoring in rising non-CO_2 gases could lower the carbon budgets by around 200 $GtCO_2$.[27]

The other important assumption in the carbon budgets is that the relationship between emissions and temperature stays linear. However, some scientists believe that at higher emissions levels the slope of the line will get steeper due to increasing stresses on natural carbon sinks (e.g., tree loss from drought and fires) and potential feedbacks (e.g., thawing permafrost) that spike CO_2 levels and warming.[28] Like running a marathon, the first twenty miles may be at the same steady pace, but the last few may be much slower as fatigue and other factors kick in.

Global Emissions

Looking at global emissions, in 2023 about 37 $GtCO_2$ was released from fossil fuel and industrial processes, a 1.1% increase from the year before. In addition, about 4 $GtCO_2$ was estimated to have been released from changes in land use (deforestation and development), a figure slightly below the year before.[29] Adding these together comes to an estimated 41 $GtCO_2$ of "anthropogenic" CO_2 emissions in 2023.[30]

While the total figure is about flat from 2022 levels, the "quality of earnings" aspect of the numbers is not as good. The larger contributor and easier to measure data – fossil fuel & industrial emissions levels – continues to rise, and the much smaller, harder to measure data – land use change – is declining.

In addition, other greenhouse gases were emitted which, when converted to their CO_2 equivalent[31], add up to a total figure of 59 $GtCO_2$ equivalent ("$GtCO_2e$") emissions in 2023. For the purposes of the carbon budget the focus is on CO_2 emissions only. However, both CO_2 and CO_2 equivalent emissions need to come down to reduce warming.

Remaining Time

The IPCC carbon budgets noted above started with the base year of 2020 and went forward. A year ago the European climate research service Copernicus published updated carbon budgets which adjusted for emissions that had occurred in the intervening years (2020, 2021, 2022, 2023) – a deduction of 164 $GtCO_2$ – and made some other small changes based on newer data.[32] The Copernicus remaining carbon budgets are shown below. Assuming 2024 emissions come in at the same level as 2023, as they are on track to do, the remaining budgets at the start of 2025 will be reduced by another 41 $GtCO_2$.

Figure 1. **Remaining Carbon Budget to 1.5ºC**[33]

Likelihood to stay under 1.5°C	50%	67%	83%
Remaining carbon budget estimate (starting in 2024)	200 ($GtCO_2$)	150 ($GtCO_2$)	100 ($GtCO_2$)
Less: estimated emissions in 2024	41	41	41
= Remaining carbon budget as of 2025	159	111	59
Assumed go-forward emissions rate per year	41	41	41
Number of years until exhausted / year	3.9 / 2028	2.7 / 2027	1.4 / 2026
Exhaustion rate per year	26%	37%	69%

Consistent with the IPCC analysis, Copernicus also notes that accounting for non-CO_2 emissions could subtract another 200 $GtCO_2$ from the budgets. **If that deduction is made, all of the 1.5°C carbon budgets go in the red.**

Looking at the 2.0°C remaining carbon budget and using the same math provides a longer runway, but it is still very tight.

Figure 2. **Remaining Carbon Budget to 2.0ºC**[33]

Likelihood to stay under 2.0°C	50%	67%	83%
Remaining carbon budget estimate (starting in 2024)	1,100 ($GtCO_2$)	900 ($GtCO_2$)	750 ($GtCO_2$)
Less: estimated emissions in 2024	41	41	41
= Remaining carbon budget as of 2025	1,059	859	709
Assumed go-forward emissions rate per year	41	41	41
Number of years until exhausted / year	25.8 / 2050	20.9 / 2045	17.3 / 2042
Exhaustion rate per year	3.9%	4.8%	5.8%

If the non-CO_2 effect of 200 $GtCO_2$ is deducted from the 2.0°C budgets, the timeframes shrink considerably.

Carbon budget after non-CO_2 deduction	859 ($GtCO_2$)	659 ($GtCO_2$)	509 ($GtCO_2$)
Number of years until exhausted / year	20.9 / 2045	16.1 / 2041	12.4 / 2037

Takeaways

1. Assuming global emissions remain approximately flat in the near term, and no adverse impact from non-CO_2 effects, **there are between 16 months and four years left before the 1.5°C carbon budgets are exhausted.** Accounting for non-CO_2 effects under any probability leaves no budget. **1.5°C of warming or more is, unfortunately, a near certainty.**

2. **2.0°C of warming is also likely** given that higher probabilities of success budgets (67%, 83%) after accounting for non-CO_2 will also be exhausted shortly (within 10 – 20 years). However, there is room to extend the runway if annual CO_2 emissions come down substantially in the near term or non-CO_2 emissions can be managed.

The short carbon budget runways also beg the question of whether "Net Zero by 2050" and its mid-century framework, although well intentioned, is still the relevant timeline.

The Long Hot Summer

The summer has provided a window into the warmer world. Temperatures have been at or near records with extreme weather in almost every region.[34]

- July's global (combined land and ocean surface) temperature ended the record streak of record months – thirteen in a row – but not by much.[35] The average temperature was 1.48°C warmer than the pre-industrial benchmark, which was a fraction less hot than the same period last year, but still the second-warmest July recorded. July also had the two hottest days since records began in 1940.[36]
- A month earlier, June marked the first twelve-month period (July 2023 to June 2024) when global temperatures reached and surpassed 1.5°C for every month. It was the longest stretch of time that global temperature remained above the 1.5°C threshold. (While the full year of 2023 was above 1.5°C, that was an average of the 12 months with some months below 1.5°C.) The July 2023 – June 2024 year was also the highest annual period on record at 1.64°C above the pre-industrial average.[37]

The increasing temperatures and ongoing high emissions have caused continuous revisions upward. In 2018, the World Meteorological Organization estimated the likelihood of temporarily hitting 1.5°C over the next five years at 10%. Four years later, in May 2022 they raised the odds to 50/50, and a year later in May 2023 they increased the odds to 66%. In June, the WMO raised the odds again to 80%.[38] Assuming the remainder of 2024 does not cool down significantly, there will be not one but two years in a row above 1.5°C.

Reports of the broken records are careful to point out that it does not mean the 1.5°C limit specified in the Paris Agreement has been breached, since the marker refers to a long-term warming trend and not a year or two. **But because recent figures are so high – even factoring in the impact of El Niño – some scientists believe warming is accelerating, and that the emphasis on decadal or multi-decadal temperature averages is understating the level of change by overweighting the "cooler" years earlier in the time sequence.[39]** (The average height of my 21-year-old son over the past decade is approximately 5'4" even though he now stands at 6'2".)

The Other Sea Change Investment Strategy

Investors crave certainty but recognize that the world is difficult to predict. Uncertainty is often due to the vagaries of human nature (emotions, animal spirits), but the science of the world is considered certain – the Earth rotates around the sun each day; water boils at 212°F; if you drop a ball it will fall to the ground.

To circle back to the start of this memo and the "sea change" in interest rates: if by some miracle of clairvoyance an investor in 1980 learned that the fed funds rate would decline from 20% to 0% over the next 30 years, he or she could shift their portfolio to take advantage of that knowledge. Not all the decisions would be right, and there would be inevitable surprises in the form of world events, innovation, and regulation. But overall, by positioning a portfolio behind the massive interest rate decline tailwind, an investor would have done very well.

The increase in global average temperature is a <u>science-based certainty</u> with a very high impact on investments in every asset class. It has more certainty than any macroeconomic forecast, demographic change, political analysis, or earnings projection that investors use for decision-making. Once the carbon budget is exhausted – unless the physics is wrong – temperatures will rise inexorably to the new equilibrium point.[26]

Rising global average temperature at and above 1.5°C or 2.0°C will have widespread effects providing a massive tailwind for some investments and a massive headwind for others. It is beyond the scope of this memo to detail warming effects across strategies and asset classes; however, a side-by-side comparison illustrates potential aspects of the transformation.

Figure 3. **Illustrative Impacts of Rising Temperatures**[40]

From	To
Carbon emissions are an "externality" – not a factor in economic decisions	Emissions are priced into all products and services, raising the costs on emissions-intensive products
Voluntary Net Zero pledges with loose timelines and little oversight	Required, regulated and monitored decarbonization commitments
Tenants and owners prize location-based, trophy commercial properties	Tenants and owners require LEED-certified, energy efficient buildings
Peacetime footing – governments encourage change through incentives and persuasion ("please join the military")	Wartime footing – governments force change as stopping warming becomes a national priority ("you have been drafted")
Water is abundant, available and cheap	Water is scarce, rationed, and costly
Invest in economically resilient assets – well positioned for the ups and downs of the business cycle	Invest in climate resilient assets – well positioned for extreme weather, heat and drought
Stores of value are gold, diamonds, art	Stores of value are arable land, water rights
Insurers underwrite based on standard, back-tested actuarial models – pricing is predictable	Insurers struggle to underwrite climate risk as historic data no longer accurate predictor – prices rise sharply
Politics and economics drive migration / refugees	Climate change drives migration / refugees
Most valuable real estate = beachfront properties	Least valuable (and un-insurable) real estate = beachfront properties
Timberland valued for wood value	Timberland valued for carbon credit value
Most important macro statistics are monthly jobs report, inflation, GDP growth	Global average temperature, atmospheric CO_2, and emissions growth are added to the list
Retire in the south – Florida, Spain	Retire in the north – Vermont, Canada
Investors arbitrage market risks	Investors arbitrage weather risks
Hedge funds hire smart "rocket scientists"	Hedge funds hire smart "climate scientists"
Business travel frequent, as needed	Business travel rare, only as required
Conspicuous consumption	Recycling and reuse
Fastest growing cities are in the Sunbelt – Austin, Phoenix, Orlando, Houston	Fastest growing cities are in the Rustbelt – Minneapolis, Buffalo, Detroit

Warming effects and the impacts on assets and portfolios can be modelled and scenario planned. For example, a base-case scenario might have global average temperatures in the 1.70°C – 2.2°C of warming range, followed by aggressive efforts to cut emissions, remove CO_2 from the atmosphere, and pull temperature back below the 1.5°C threshold. While scenarios and degree of warming may vary, we believe the general direction of investments to be made (more renewables, decarbonized products and services, climate solutions technologies) and avoided (highly emissions intensive products, weather exposed assets) is clear.

Conclusion

The impact across multiple areas and assets of increasing warming and consequent climate alterations presents a compelling "sea change" in the investment landscape, one of the largest in the years ahead.

As the economist Herbert Stein once noted, "if something cannot go on forever, it will stop." At some point – and I think it will be sooner than many expect – the reality of warming will set in, accelerating efforts to reduce emissions and decarbonization. Human beings have a powerful survival instinct. The recent response to the global pandemic – demonstrated in earlier responses to war and other major events – shows that change can happen quickly and effectively when required.

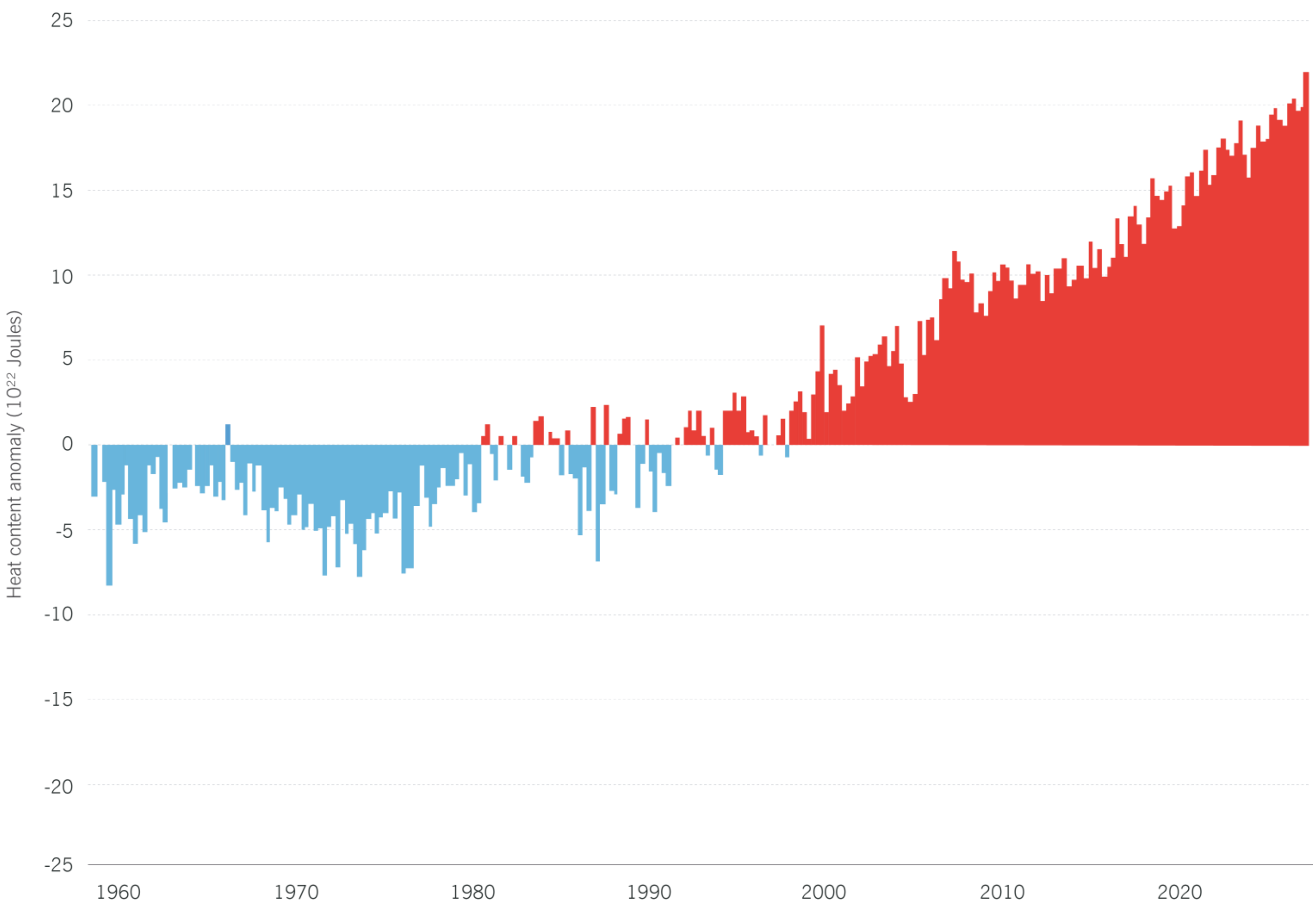
Private capital will have a unique opportunity to fund and foster that transformation. Private capital will also be needed to fund many of the products and services required to adapt to the warmer, changing world. The compressed timeframes required to decarbonize, scope of required change, and favorable government policies could create powerful supporting tailwinds for these investments.

The influx of private sector capital, expertise and innovation at scale and with urgency can be the difference maker that will ensure the "other sea change" does not go too far.

Exhibits: Select Charts

Exhibit 1. **Ocean Temperature Change**[41]

Ocean heat compared to average

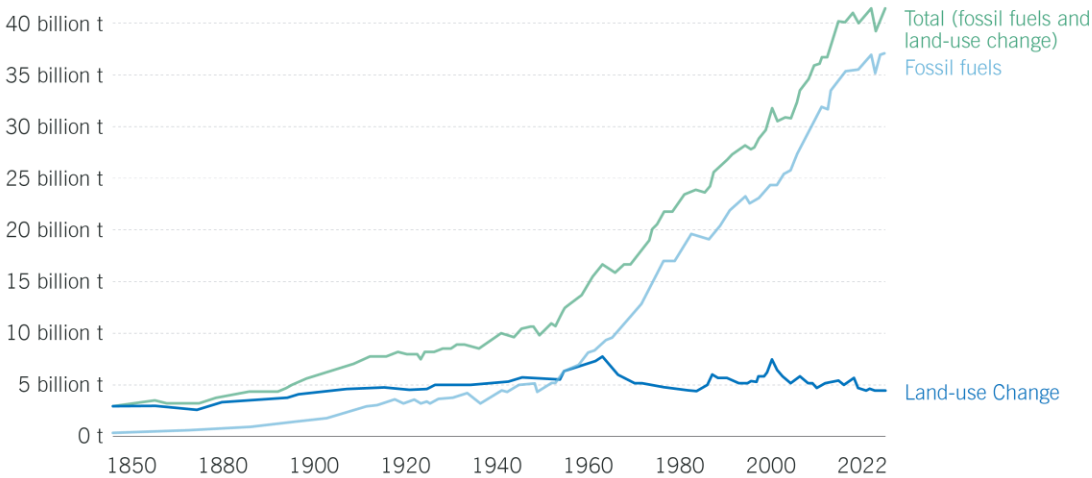


Seasonal (3-month) heat energy in the top half-mile of the ocean compared to the 1955-2006 average. Heat content in the global ocean has been consistently above-average (red bars) since the mid-1990s. More than 90 percent of the excess heat trapped in the Earth system due to human-caused global warming has been absorbed by the oceans.

Exhibits: Select Charts *(Cont.)*

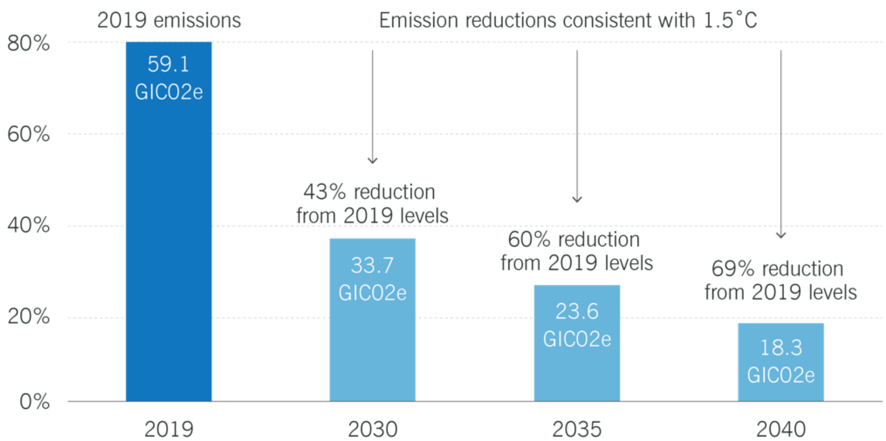
Exhibit 2. **CO_2 Emissions**[42]

CO_2 Emissions from fossil fuels and land-use change, World



Data Source: Global Carbon Budget (2023).

GHG Emissions reductions needed to keep 1.5°C within reach



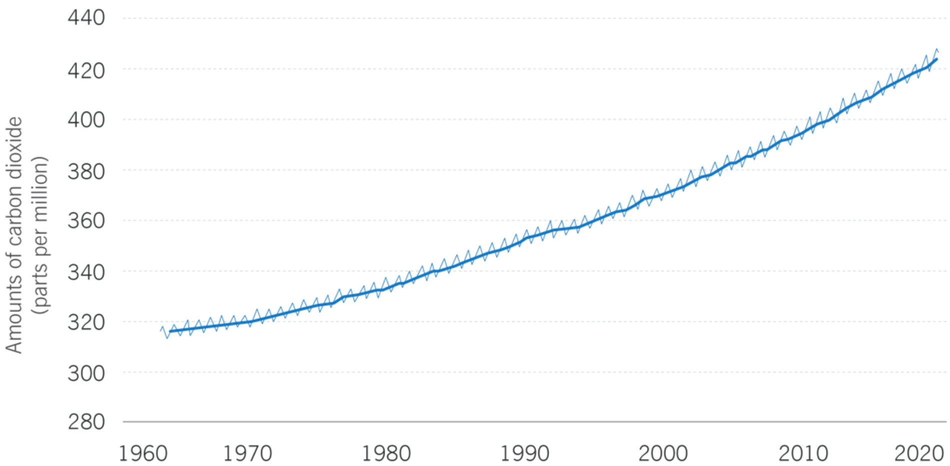
Source: IPCC AR6.

The most recent *Emissions Gap Report, 2023* – an annual independent science-based analysis utilizing new studies and climate modeling — compares (a) the level of global emissions including CO_2 equivalents (CO_2 and other gases expressed as "CO_2e") in 2030 required to meet the Paris Agreement goals (as above, a 43% reduction from 2019 levels to stay within 1.5 °C of warming) and (b) the emissions level if countries implemented their pledges under the Paris Agreement (their "nationally determined contributions"). The report finds that the gap between the goal and commitments is very large, approximately 20 GtCO_2e for 1.5°C and more than 10 GtCO_2e for 2.0°C. However, even the national commitments that have been made are not yet being met, compounding the challenge. As the report states, "even in the most optimistic scenario considered in this report, the chance of limiting global warming to 1.5 °C is only 14 percent, and the various scenarios leave open a large possibility that global warming exceeds 2 °C or even 3°C."

Exhibits: Select Charts *(Cont.)*

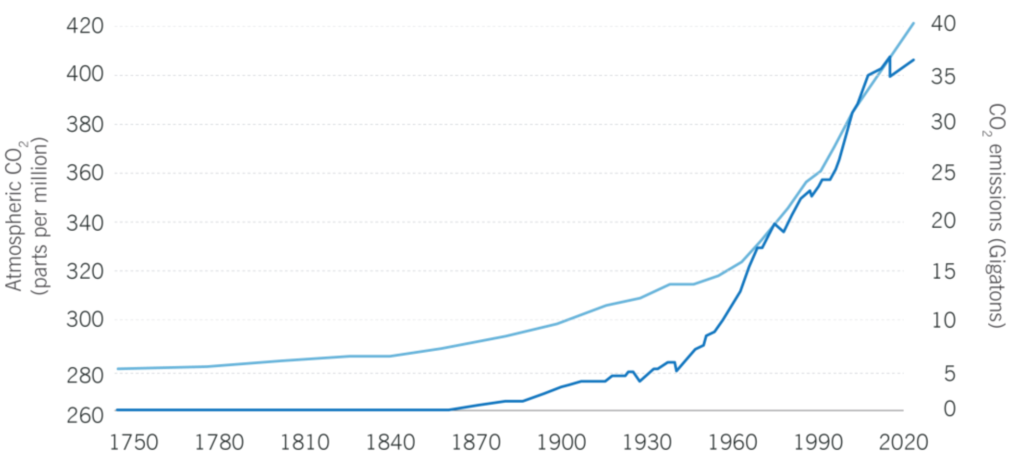
Exhibit 3. **Atmospheric CO_2[43]**

Atmospheric carbon dioxide



Data Source: Global Carbon Budget (2023).

Global atmospheric carbon dioxide compared to annual emissions (1751-2022)



Source: IPCC AR6.

About half of anthropogenic CO_2 emissions stay out of the atmosphere and are (i) either dissolved into the ocean, where they increase ocean acidity but do not directly impact warming, or (ii) are absorbed on land (through vegetation growth, soils). The other half remains in the air where small changes in CO_2 concentration make a major impact, similar to how a small percentage change in blood alcohol percentage – 0.08% – crosses over to intoxication. The modern record of atmospheric carbon dioxide levels began with observations recorded at Mauna Loa Observatory in Hawaii. This graph shows the station's monthly average carbon dioxide measurements since 1958 in parts per million (ppm). The seasonal cycle of highs and lows (small peaks and valleys) is driven by Northern Hemisphere summer vegetation growth, which reduces atmospheric carbon dioxide, and winter decay, which increases it. Atmospheric CO_2 averaged 421 parts per million (ppm) in 2023 versus concentrations in the pre-industrial benchmark period of around 280 ppm – an increase of 140 ppm or about 50%. 2023 was the 12th consecutive year CO_2 increased by more than 2 ppm, extending the highest sustained rate of CO_2 increases during the 65-year monitoring record. Atmospheric CO_2 concentrations are now higher than at any time in at least 2 million years.

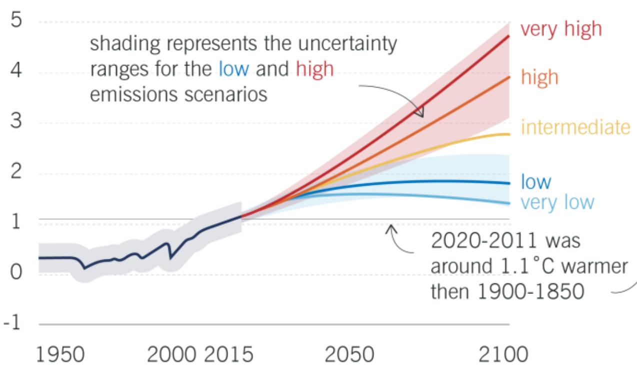
Exhibits: Select Charts *(Cont.)*

Exhibit 4. **Climate Impacts**[44,45]

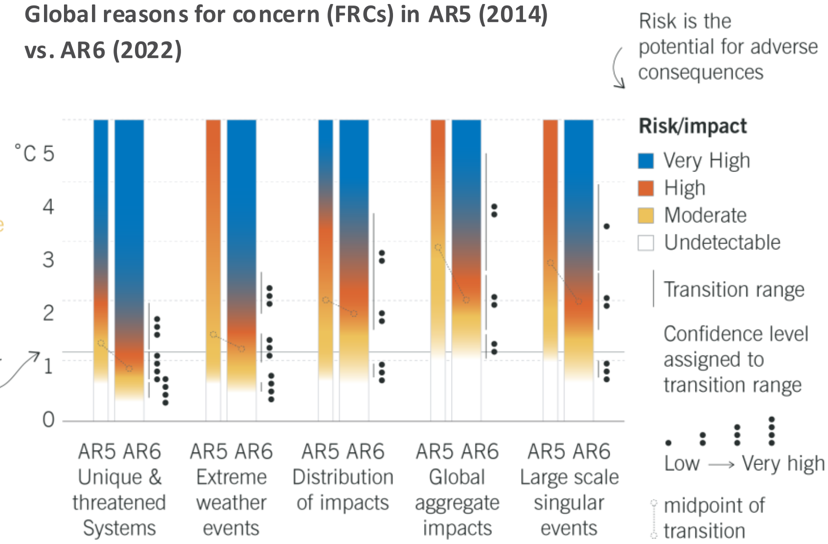
Risks are increasing with every increment of warming

High risks are now assessed to occur at lower global warming levels

Global surface temperature change relative to 1850-1900

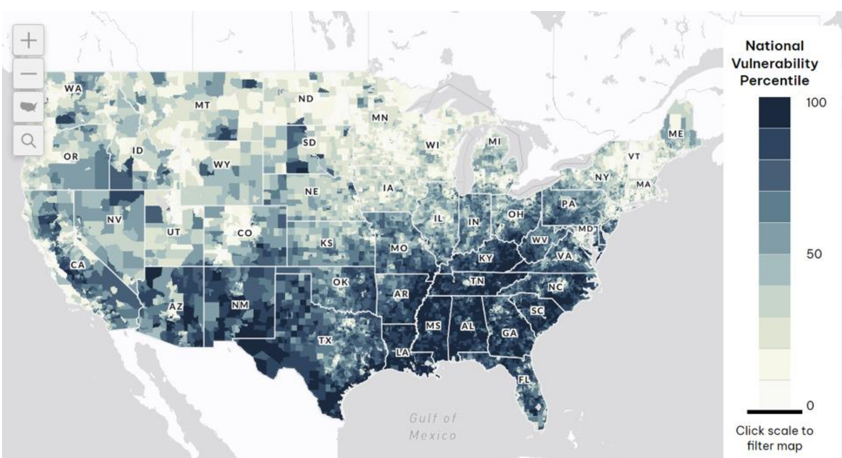


Global reasons for concern (FRCs) in AR5 (2014) vs. AR6 (2022)



Overall Climate Vulnerability

Score combining environmental, social, economic and infrastructure effects on neighbourhood-level stability



The IPCC uses a framework of five "reasons for concern" which rise in severity with increases in the Earth's global mean temperature. The five reasons for concern are: (1) unique and threatened systems, e.g., coral reefs, the Arctic, mountain glaciers; (2) extreme weather events, e.g. heatwaves, heavy rains, drought, wildfires, coastal flooding; (3) distribution of impacts, harm to vulnerable socio-economic peoples and systems; (4) global aggregate impacts; and, (5) large scale singular events, e.g., ice sheet disintegration.
How these impacts effect different regions varies, and various intelligence services are developing to model the impacts at a granular level. The second graphic is an analysis developed in partnership between Texas A&M University and the Environmental Defense Fund – the U.S. Climate Vulnerability Index -- which combines 184 sets of publicly available data to rank more than 70,000 U.S. census tracts and show where heat and other climate risks threaten the stability of communities. The darker sections illustrate the areas most at risk.

Endnotes

1. Howard Marks, "Sea Change", December 13, 2022. Oaktree Capital (www.Oaktreecapital.com)
2. The prime lending rate reached its high of 21.5% on December 19, 1980.
3. "Climate Change: Ocean Heat Content", September 6, 2023. NOAA (www.climate .gov)
4. Sea surface temperature is measured at shallow depths over the ocean area that excludes the polar waters, an area referred to as "over 60°S–60°N latitudes".
5. Copernicus Climate Change Service (www.climate.copernicus.eu).
6. Climate Change: Global Sea Level, NOAA (Climate.gov).
7. What percentage of the American population lives near the coast?, National Ocean Service (oceanservice.noaa.gov).
8. U.N. Atlas of the Oceans (oceanatlas.org)
9. "The uninsurable world: how the insurance industry fell behind on climate change," Ian Smith & Kenza Bryan, Financial Times, June 2, 2024.
10. Sea water temperature. Sea surface temperatures on the coast (seatemperature.info).
11. Transfer and Storage of Heat in the Oceans, Center for Science Education (ucar.edu)
12. Henley, B.J., McGregor, H.V., King, A.D. et al. Highest ocean heat in four centuries places Great Barrier Reef in danger. Nature 632, 320–326, 2024.
13. One of the major revisions recommended by the IPCC and written into the Paris Agreement in 2015, was to lower the consensus "ceiling" limit on warming from 2.0°C to 1.5°C. One half a degree was a huge revision, and the IPCC laid out its thinking and the science in a long report, "Global Warming of 1.5°C." It describes multiple severe climate impacts that increase or accelerate above 1.5°C. The metric is not binary – no switch is flipped at 1.5°C or 2.0°C – but is a general indicator / best scientific estimate of where climate impacts significantly worsen. While 1.5°C and 2.0°C are the consensus goals, there is, not surprisingly, strong disagreement with consensus. The figures are simply too high in the opinion of many good scientists who believe they understate the risks, damages and in some cases irreversible changes that will occur at lower levels of warming, as evidenced by the global climate impacts already unfolding under the current estimated 1.1°C (1.98°F) of warming (2011 – 2020 decade). See Global Warming of 1.5 ºC — (ipcc.ch)
14. 1.5°C to 2.0°C are the level of warming since the pre-industrial benchmark (1850 – 1900) and are typically calculated as ten-year or multi-decadal averages to account for short term variations.
15. Chapter 5: Global Carbon and other Biogeochemical Cycles and Feedbacks | Climate Change 2021: The Physical Science Basis (ipcc.ch).
16. The IPCC defines the remaining carbon budget as: "The maximum amount of cumulative net global anthropogenic CO2 emissions that would result in limiting global warming to a given level with a given probability, taking into account the effect of other anthropogenic climate forcers. This is referred to as the total carbon budget when expressed starting from the pre-industrial period, and as the remaining carbon budget when expressed from a recent specified date."
17. Under the greenhouse effect, global average temperature will be forced up until it reaches the new equilibrium point set by the higher CO2 concentration. The converse is also true: falling atmospheric CO2 levels will cause the temperatures to cool until the new lower equilibrium point is reached.
18. Ricke, Katharine L., and Ken Caldeira. "Maximum warming occurs about one decade after a carbon dioxide emission." Environmental Research Letters 9.12 (2014): 124002. Abstract: "It is known that carbon dioxide emissions cause the Earth to warm, but no previous study has focused on examining how long it takes to reach maximum warming following a particular CO2 emission. Using conjoined results of carbon-cycle and physical-climate model intercomparison projects (Taylor et al 2012, Joos et al 2013), we find the median time between an emission and maximum warming is 10.1 years, with a 90% probability range of 6.6–30.7 years. We evaluate uncertainties in timing and amount of warming, partitioning them into three contributing factors: carbon cycle, climate sensitivity and ocean thermal inertia. If uncertainty in any one factor is reduced to zero without reducing uncertainty in the other factors, the majority of overall uncertainty remains. Thus, narrowing uncertainty in century-scale warming depends on narrowing uncertainty in all contributing factors. Our results indicate that benefit from avoided climate damage from avoided CO2 emissions will be manifested within the lifetimes of people who acted to avoid that emission. While such avoidance could be expected to benefit future generations, there is potential for emissions avoidance to provide substantial benefit to current generations."
19. The IPCC – the Intergovernmental Panel on Climate Change – is a collaboration of leading scientists from around the world representing multiple nations and tasked by the U.N. to review the available scientific literature and make climate policy recommendations, which they do through periodic reports. Like many groups that require consensus from multiple parties, the IPCC is regarded as cautious, but their carefully worded reports have grown more urgent as warming effects become more visible.
20. Emissions are measured in metric tons or tonnes and a gigatonne is 1,000 metric tonnes.
21. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Chapter 5: Global Carbon and Other Biogeochemical Cycles and Feedbacks, Climate Change 2021: The Physical Science Basics.
22. Under the Paris Agreement language of "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels," 50% is the target used for 1.5°C ("pursue efforts") and 67% and 83% are the probabilities used for 2.0°C.
23. As the IPCC reported stated, "The central case RCB [remaining carbon budget] assumes future non-CO2 warming (the net additional contribution of aerosols and non-CO2 GHG) of around 0.1°C above 2010–2019 in line with stringent mitigation scenarios. If additional non-CO2 warming is higher, the RCB for limiting warming to 1.5°C with a 50% likelihood shrinks to around 300 GtCO2." IPCC_AR6_SYR_LongerReport.pdf (p. 82)
24. "Comments on Global Warming Acceleration, Sulfur Emissions, Observations", May 16, 2024, James Hansen, Pushker Kharecha, Makiko Sato (www.columbia.edu).
25. The most problematic non-CO2 gas is methane, the bad boy of greenhouse gases. Methane does not stay around for long (a lifespan of 7 to 12 years in the atmosphere) but is a much stronger greenhouse gas than CO2 in terms of its warming effect. Over a 20-year period, one metric ton of methane has a warming potential 84 to 87 times greater than carbon dioxide. Over a 100-year timescale, and without considering climate feedback, one metric ton of methane would generate around 28 times the amount of warming as one ton of CO2. Methane levels have been rising, in part, due to the increasing use of Liquid Natural Gas (LNG) which has been marketed as a "bridge fuel" for the energy transition and is primarily composed of methane. As LNG is sourced and transported, methane leaks; as it is a gas and not a fluid like oil, those leaks are not easily detected and can persist.

Endnotes *(Cont.)*

26. AR6 Synthesis Report, Climate Change 2023, A.1.3 (IPCC.ch), March 2023.
27. AR6 Synthesis Report, Climate Change 2023, 3.3.1 (IPCC.ch), March 2023.
28. "Assessing the size and uncertainty of remaining carbon budgets." Lamboll, R.D., Nicholls, Z.R.J., Smith, C.J. et al. Nature Climate Change. 13, 1360–1367 (2023). Changing the transient climate response to cumulative CO2 emissions ("TCRE" equating to temperature rise per unit of carbon emitted) from a linear to logarithmic equation would reduce carbon budgets but is extremely complex to model. An additional assumption is around the level of warming once emissions reach zero – zero emissions commitment or "ZEC" – which depends, in part, on the thermal inertia of the oceans and the "built in" warming already present. (Note: there is no shortage of acronyms in climate.) The latest Earth system model simulations find that at present levels of warming, this release of heat may be mostly balanced by the natural carbon cycle, which will begin incrementally reducing atmospheric carbon dioxide levels right away. If these models are correct, the amount of warming that can be expected once greenhouse gas emissions reach zero is at most a few tenths of a degree Celsius over a decade, and may be closer to zero. This is a central assumption behind "net zero".
29. Fossil CO2 emissions at record high in 2023, Global Carbon Project (globalcarbonbudget.com).
30. Emissions figures refer to three categories of emissions and which one is being referenced is not always clear. The first category is CO2 / carbon dioxide emissions which come from fossil fuels and industrial uses (i.e., concrete and steel). The second category is emissions which come from land use changes (i.e., cutting down trees for farming or development). Together those categories are referred to as "anthropogenic" CO2 emissions. The third category are the combination of CO2 and other greenhouse gases, methane (CH4), the fluorinated gases (F-gases) and nitrous oxide (NO2).
31. Because the physical and chemical composition of gases are different, non-CO2 greenhouse gases have different warming effects in the atmosphere than CO2 and remain in the atmosphere for different periods of time. To provide a common means of expression, the global warming potential of a greenhouse gas is described within a time period, e.g., the "100-year global warming potential", or the "20-year global warming potential" and calculated to show how much CO2 would have to be emitted to have an equivalent warming impact to the amount of the other greenhouse gas, in aggregate this becomes the CO2 equivalent emissions figure.
32. Global Carbon Budget 2023, Earth System Science Data (essd.copernicus.org).
33. Investcorp analysis using data from Earth System Science Data as of December 2023.
34. Extreme heat is breaking global records: Why this isn't 'just summer,' and what climate change has to do with it, The Conversation, July 2024.
35. July was second warmest on record, ending record-breaking 13-month streak, Copernicus Climate Change Service (climate.Copernicus.eu).
36. Illustrating how thin the margin was to continuing the record, the NOAA recorded July temperature as the warmest July in NOAA's 175-year global record and continuing the record warming streak: Earth just had its warmest July on record, National Oceanic and Atmospheric Administration (noaa.gov).
37. Surface air temperature for June 2024, Copernicus Climate Change Service (climate.Copernicus.eu).
38. Global temperature is likely to exceed 1.5°C above pre-industrial level temporarily in next 5 years, World Meteorological Organization (wmo.int).
39. The warming rate of 0.18C per decade seen since 1970 has almost doubled to roughly 0.3C per decade over the past 15 years. "Factcheck: Why the recent 'acceleration' in global warming is what scientists expect," CarbonBrief (carbonbrief.org).
40. Investcorp analysis of the illustrative impacts of rising temperatures.
41. Based on data (0-700m) from the NCEI Ocean Heat Content product collection, NOAA (Climate.gov), September 2023.
42. ClimateActionTracker.com.
43. NOAA (Climate.gov).
44. AR6 Synthesis Report, Climate Change 2023, SPM.4 (IPCC.ch), March 2023.
45. The U.S. Climate Vulnerability Index (climatevulnerabilityindex.org), September 2024.

About Investcorp

Investcorp is a global investment manager, specializing in alternative investments across private equity, real estate, credit, absolute return strategies, GP stakes, infrastructure, strategic capital, and insurance asset management. Since our inception in 1982, we have focused on generating attractive returns for our clients while creating long-term value in our investee companies and for our shareholders as a prudent and responsible investor.

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Note: Investcorp as of July 2024. Please refer to www.investcorp.com/sustainability/ and www.investcorp.com/diversity-and-inclusion/ for additional information about Investcorp's responsible business and diversity, equity and inclusion practices.

About Investcorp Climate Solutions

Investcorp's Climate Solutions business brings Investcorp's combination of capital, business-building services, international network and investment experience to the leading companies addressing decarbonization and climate change. Investcorp believes the climate solutions industry is comparable to the disruption and wealth creation of the digital revolution which gave rise to rapidly dominant new businesses, created new markets, and drove major operational changes. However, the climate solutions industry will transpire in a more limited timeframe given near-term climate risks.

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