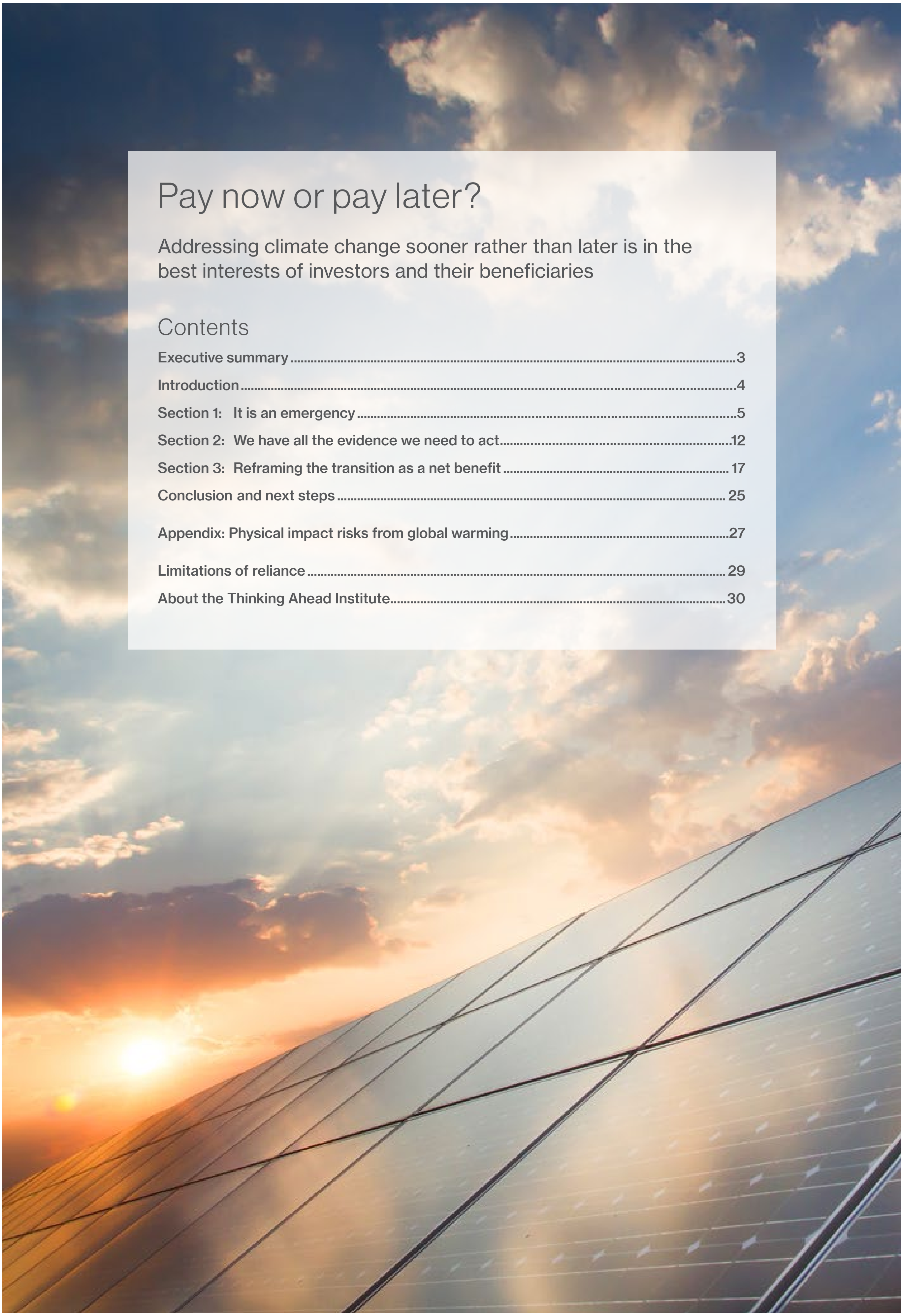
Thinking Ahead Institute

Pay now or pay later?

Addressing climate change sooner rather than later is in the best interests of investors and their beneficiaries



Pay now or pay later?

Addressing climate change sooner rather than later is in the best interests of investors and their beneficiaries

Contents

Executive summary

The investment industry is not acting swiftly and definitively enough on its net-zero commitments. As an industry we are not seeing the bold decisions needed, the infrastructure built to secure success, or the investing required today. The purpose of this paper is to provide evidence and analysis to support the climate beliefs required to drive increased action on climate. To demonstrate to the industry that we must pay now to address climate risks, or we will be required to pay more later.

It is an emergency

This paper evidences that climate change is an emergency. Humanity is no longer on a path towards 1.5°C warming, as the most 'optimistic' temperature rise scenario is 1.8°C by 2100.[1] If humanity continues along the 'business-as-usual' path that it is currently on it is likely that the temperature will rise between 2.7°C-3.6°C. If historical underestimations of climate change, political lobbying that is influencing the pace of action and the fact that humanity can only run one path into the future are taken into account, the latter temperature prediction is even more likely. The authors of this paper believe that we have a choice between an immediate and rapid transition of the economy to net-zero carbon, or an inevitable transition of the climate to a state that scientists have deemed unsafe.

We have all the evidence we need to act

The world is already experiencing warming of 1.2°C. At this temperature rise the physical risk impacts, experienced across the world have been numerous and severe, highlighting that as an industry we have all the evidence that we need to act. If we also account for climate tipping points and acknowledge the importance of addressing systemic risk, there is even more impetus to act now with the tools that the industry is equipped with rather than waiting for improved data and analytics.

"… we could see a 50-60% downside to existing financial assets in a business-as-usual scenario …"

Reframing the transition as a net benefit

If the industry acts now there will be costs, but these will be materially less than those arising from a late transition or no transition at all. If climate tipping points, that could magnify the costs of inaction, are considered we could see a 50-60% downside to existing financial assets in a business-as-usual scenario where climate risks are not addressed. In contrast, **taking action to transition to a well below 2°C world might lead to a loss of 15% of existing assets** which could be partly offset by the positive benefits from new primary investment. Taking action to steward a highly co-ordinated and orderly-as-possible transition of the economy could, potentially, further mitigate transition costs.

The authors of this paper believe that we have a choice to act now and minimise further climate change, or to delay action to preserve the economy in its current form and suffer the consequences. These will include both the increased costs of adaptation and physical impact risks globally far beyond those occurring currently. If humanity hopes to limit warming to well below 2°C we must see a full implementation of all announced climate targets by governments but also a recognition by the investment industry that we are part of the economic system that can and must address it.

The actions that the investment industry can take are largely out of the remit of this paper. However, the Thinking Ahead Institute has already made several suggestions:

- A six-step action plan for net-zero
- Investment beliefs to change the climate trajectory (adopt the stop, substitute, siphon framework, develop new investment conventions, and commit to meaningful collaboration)
- We've decided to address climate change: getting our own house in order (address and direct internal resources towards climate action)
- 3D net-zero mandates (revisit external resources and consider 3D investing mandates)
- How much of the climate problem does the investment industry own, and what should it do about it? The answer is a lot more primary investment (more primary investment)
- Beyond ESG: System solutions for sustainability (adopt and apply systems thinking)

[1] "The CAT Thermometer", *Climate Action Tracker.*

Introduction

The investment industry is at an inflection point regarding climate change.[2] In less than two years we have gone from the establishment of the Net-Zero Asset Owner Alliance (NZAOA) and Net Zero Asset Managers Initiative (NZAMI) to memberships representing USD10.6 trillion and USD61.3 trillion in assets under management respectively.[3,4]

Despite these pledges, the authors of this paper believe that we are not seeing the widespread action required to reach net-zero carbon emissions, from the investment industry or from governments. This paper aims to provide evidence and analysis to support a rapid acceleration of action from this inflection point.

Section 1 explores the climate path humanity is currently on and shows that it is likely that the planet will breach 1.5°C much sooner than anticipated with the 'optimistic' temperature increase scenario sitting at 1.8°C.[5] It provides evidence that if humanity continues to act in a manner conducive to 'business-as-usual' we are likely to see warming that exceeds 2.7°C.[6] The associated physical risks at 2.7°C are much more severe than at 1.8°C. If the historical underestimations in climate science, the threat of political lobbying and the fact that we only get one shot at the future are considered, it is clear that climate change is an emergency.

"Acting ambitiously now will incur financial costs, but these will be materially less than those arising from a late transition, or no transition at all."

The authors of this paper believe that the investment industry has all the evidence needed to act. We are currently living in a 1.2°C world and there is evidence that severe weather events are happening all around us more often and with greater impact. Section 2 explores the extreme weather events that have been experienced in the last two years and presents a case for considering systemic risk and climate tipping points. It concludes that no new information is needed, but rather that it is time for investors to act.

Acting ambitiously now will incur financial costs, but these will be materially less than those arising from a late transition, or no transition at all. Section 3 includes a cost-benefit analysis that lays out that as an industry we have a choice. We either make productive investments now and build a new economy in an organised fashion, and on our terms, or we will incur these costs, and more, in the future as we are required to protect humans against a more dangerous environment. This cost-benefit analysis is carried out through the lens of an investment portfolio although it is recognised that there are innumerable other benefits to acting now. Such as, health benefits from reduced pollution, populations not displaced and biodiversity resilience. The authors of this paper believe that whether we act and how we will act depends on what we choose to value most, the current economic model or the climate.

This paper aims to empower investors with the proof that the time for action is now. It is time that investors act on their net-zero pledges and implement tangible solutions to place the world on the most 'optimistic' path of warming and greatly reduce associated physical risks and costs.

[2] Attracta Mooney, "Investment industry at 'tipping point' as $43tn in funds commit to net zero", *Financial Times*, 6 July, 2021.
[3] "The Net Zero Asset Managers Initiative", *Net Zero Asset Managers Initiative*, last modified 2022.
[4] "Institutional investors transitioning their portfolios to net zero GHG by 2050", *UNEPFI*, last modified 2022.
[5] "The CAT Thermometer", *Climate Action Tracker*, last modified 9 November, 2021.
[6] "The CAT Thermometer", *Climate Action Tracker*.

Section 1: It is an emergency

Climate change is an emergency. In an emergency it is necessary to act immediately, and with urgency. It is clear that the time for debate is past and that humanity will face a significant transition. The choice is between an immediate and rapid transition of the economy, to net-zero carbon, or a transition of the climate to a state that scientists have deemed unsafe. Two scenarios will be compared – lower and higher amounts of warming – and a number of factors which impact the relative likelihood of each.

It is becoming increasingly clear that the planet will likely breach 1.5°C warming much sooner than first anticipated. The World Meteorological Organisation (WMO) has reported that there is a 48% chance that global near-surface temperature exceeds 1.5°C in one of the years between 2022 and 2026 with a predicted temperature range between 1.1 and 1.7°C above preindustrial levels.[7] It is now evident that 1.8°C by 2100, not 1.5°C, is the most plausible 'optimistic' temperature rise scenario.[8]

"The World Meteorological Organisation (WMO) has reported that there is a 48% chance that global near-surface temperature exceeds 1.5°C in one of the years between 2022 and 2026 …"

Since the 1970s international scientists have been warning the world about global warming and the need to limit greenhouse gas (GHG) emissions.[9] There have been leaps and bounds in science since. Improved computer models and collation of data have allowed the design of climate models that predict future climate outcomes such as temperature rise and physical impacts under a range of scenarios (see Appendix for a list of physical impacts that are predicted to occur within a temperature rise range of 1.2-4.5°C).

The outcomes of these climate scenarios are based on assumptions of current and future government policy implementation across all sectors of the economy. Since the 1980s, the climate policy discussion has largely centred on cost and how certain policies will affect economic growth. This has slowed progress towards meaningful action.[10]

Climate Action Tracker (CAT) has developed four climate scenarios to project climate outcomes, the lowest and highest warming scenarios will be considered here to establish a plausible range of outcomes.[11,12] The 'optimistic' scenario is the most ambitious policy scenario and is predicted to lead to a median temperature rise of 1.8°C by 2100. The 'business-as-usual' scenario is based on policies that are currently implemented and predicts a median rise of 2.7°C with plausible temperature rise outcomes ranging up to 3.6°C.

7 It notes there is only a small chance (10%) that the five-year mean exceeds 1.5°C. See World Meteorological Organization, *Global Annual to Decadal Climate Update* (UK, WMO, 2022).

8 "The CAT Thermometer", *Climate Action Tracker*.

9 The idea of the greenhouse effect was first published in 1896, and so attaching a specific date to a formed consensus on global warming can be debated. The history documented in 'The Discovery of Global Warming' is informative and persuasive. See- Spencer R. Weart, *The Discovery of Global Warming*, (Cambridge, Massachusetts: Harvard University Press, 2012).

10 Kate Yoder, "True costs: How the oil industry cast climate policy as an economic burden", *Grist*, April 7, 2022.

11 Climate Action Tracker (CAT) is "independent scientific analysis produced by two research organisations tracking climate action since 2009"

12 "The CAT Thermometer", *Climate Action Tracker*.

The physical impacts at 2.7°C will be numerous. For example, about 65% of the world's megacities should expect at least one day per year with a heat index above 40.6°C, which is a danger to life. This level of warming also carries the risk that the Amazon rainforest turns into savannah.[13,14] This would increase greenhouse gas (GHG) emissions from tree dieback, among other effects.

'Optimistic' scenario (lowest warming)

The CAT 'optimistic' scenario examines net-zero emissions targets that have been adopted or are under discussion by 140 countries.[15] For example, the UK has passed a law formally establishing a net-zero target by 2050.

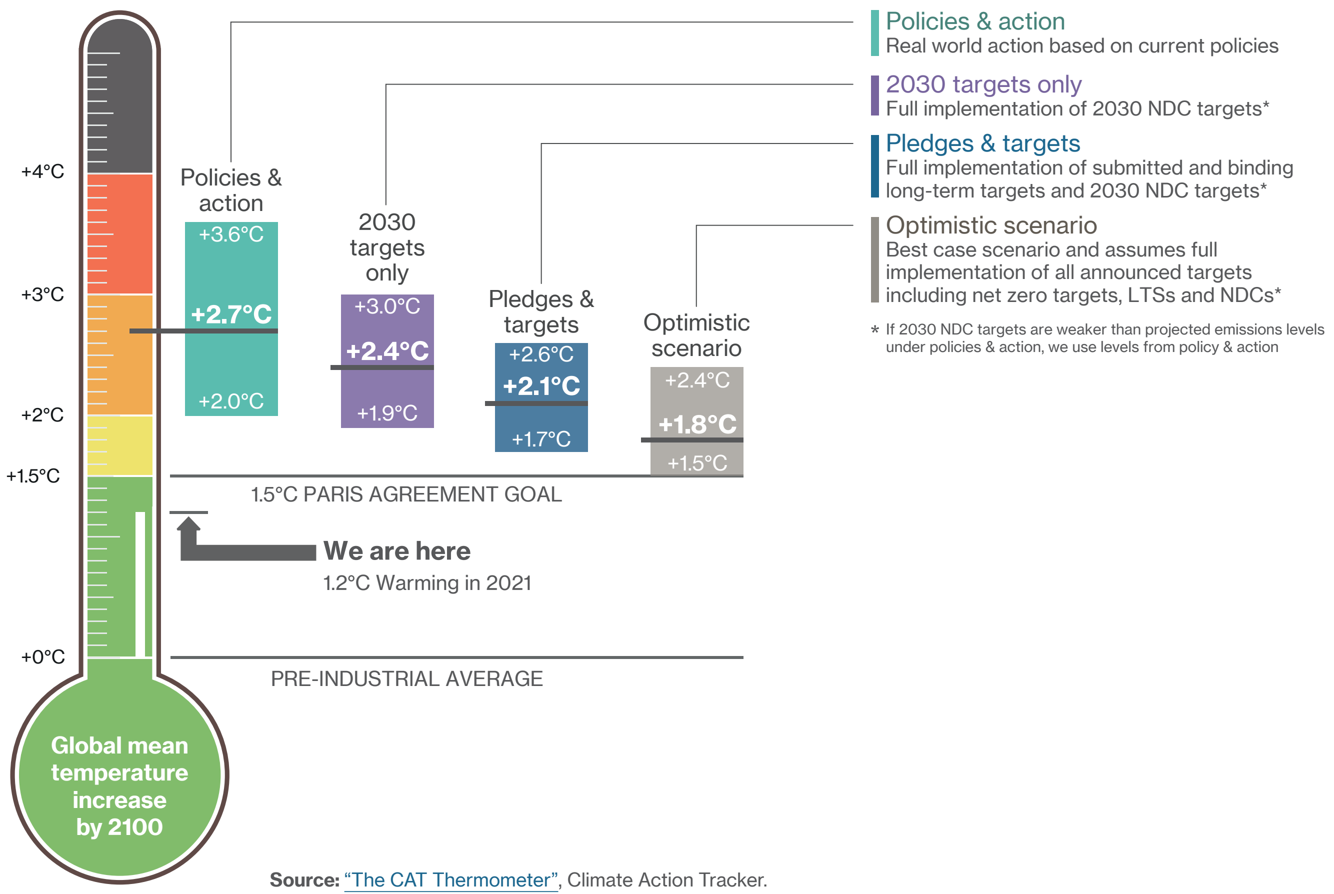
This 'optimistic' scenario assumes that there is full implementation of all announced targets including net-zero targets, long term strategies (LTS) and nationally determined contributions (NDC).[16] If governments actually implement these policies, the projected median temperature increase for the planet is 1.8°C.

Net zero targets – focus on GHG emission cuts in line with achieving a net-zero balance of GHG emissions produced and removed from the atmosphere. There is a global focus on achieving net-zero by 2050.

Long-term strategies (LTS) – "set out long-term goals for climate and development and direct short-term decision-making to support the necessary shifts to limit global warming". They provide "a vital link between shorter-term NDCs and the long-term objectives of the Paris Agreement".[17]

Nationally determined contributions (NDC) – are "climate action plan(s) to cut emissions and adapt to climate impacts. Each Party to the Paris Agreement is required to establish an NDC and update it every five years".[18]

Figure 1 – **CAT warming projections.** Global temperature increase by 2100.



Source: "The CAT Thermometer", Climate Action Tracker.

[13] Hans Portner et al., IPCC WGII Sixth Assessment Report: Technical Summary, (Geneva: IPCC, 2022), p. 40.
[14] This and several other physical impact scenarios described in this paper are taken from the 2022 IPCC report and are summarised in the appendix
[15] "Temperatures", *Climate Action Tracker, last modified 2021.*
[16] "The CAT Thermometer", *Climate Action Tracker.*
[17] "What is a Long-term Strategy?" *World Resources Institute*, last modified 2022.
[18] "For a liveable climate: Net-zero commitments must be backed by credible action", *United Nations Climate Action*, last modified 2022.

A temperature rise of 1.8°C is significantly higher than our current 1.2°C of warming. It is projected to lead to physical impacts such as a 70-90% decline in coral reefs (which is predicted to occur at 1.5°C) and increased water scarcity.[19] Coral reefs support marine life and so their decline threatens the livelihood and food supply of coastal communities worldwide. Increased water scarcity threatens everyone, although some communities are more vulnerable than others. Water scarcity has been linked to conflict and migration as people abandon their homes in search of economic and social opportunities that have been lost due to lack of water.[20]

It is important to note that this scenario is not compatible with the Paris Agreement well below 2°C warming limit. 90% of global emissions are currently covered by country-by-country targets however there has been insufficient action (actual or pledged) so far to achieve them.[21] To reach net-zero by 2050 it is reported countries would need to cut emissions by 45% by 2030 compared to 2010 levels. Currently there is a projected rise in emissions of 14% by 2030 based on all available NDCs.[22]

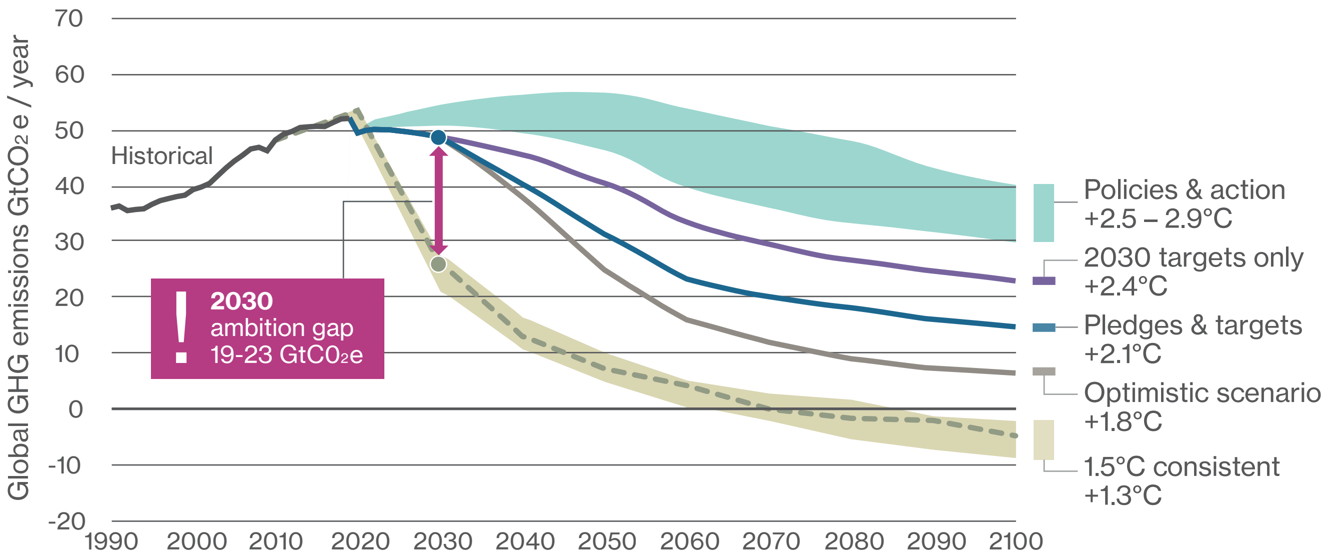
Physical risks – "arising from damage to property, infrastructure, and land".[23]

Transition risk – "results from changes in climate policy, technology, and consumer and market sentiment during the adjustment to a lower-carbon economy".[24]

Acute risk – extreme weather-related events which "include droughts, floods, extreme precipitation and wildfires".[25]

Chronic risk – refers to gradual changes such as sea-level rise, and also includes "rising temperatures, the expansion of tropical pests and diseases into temperature zones, and an accelerating loss of biodiversity".[26]

Figure 2 – **2100 Warming projections.** Emissions and expected warming based on pledges and current policies.



Source: "2100 Warming Projections", *Climate Action Tracker*.

In practice

There was a lot of pressure on the United Kingdom (UK) government in the lead up to hosting COP26. As a result, it set ambitious domestic reductions targets and is now considered a world leader as it is among very few in the world that have set targets compatible with 1.5°C. Such targets include a ban on new sales of fossil-fuel only cars from 2030 onwards. However, there remain extensive policy gaps to achieving these targets.[27] Although the UK's NDCs target a reduction in emissions of 68% below 1990 levels, it is currently on a path to a 54-56% reduction.[28] CAT has rated the UK's policies and actions as "almost sufficient".

[19] Portner et al., *IPCC WGII Sixth Assessment Report: Technical Summary*, p. 41.
[20] Schmeier et al., "Water scarcity and conflict: Not such a straightforward link", *Great Insights Magazine*, October 21, 2019.
[21] "Glasgow's 2030 credibility gap: net zero's lip service to climate action", *Climate Action Tracker*, last modified September 11, 2021.
[22] "COP26: Update to the NDC Synthesis Report", *UNFCC*, November 4, 2021.
[23] Pierpaolo, Grippa, Jochen Schmittmann and Felix Sunthaim, "Climate Change and Financial Risk", International Monetary Fund, December, 2019.
[24] Grippa, Schmittmann and Suntheim, "Climate Change and Financial Risk".
[25] IMPAX Asset Management, Physical Climate Risk: Designing a resilient response to the inevitable impact of climate change, September, 2020, p. 3.
[26] IMPAX Asset Management, Physical Climate Risk, p. 3.
[27] 2022 Progress Report to Parliament, UK: Climate Change Committee, 2022.
[28] "United Kingdom", *Climate Action Tracker*, last modified November 16, 2019.

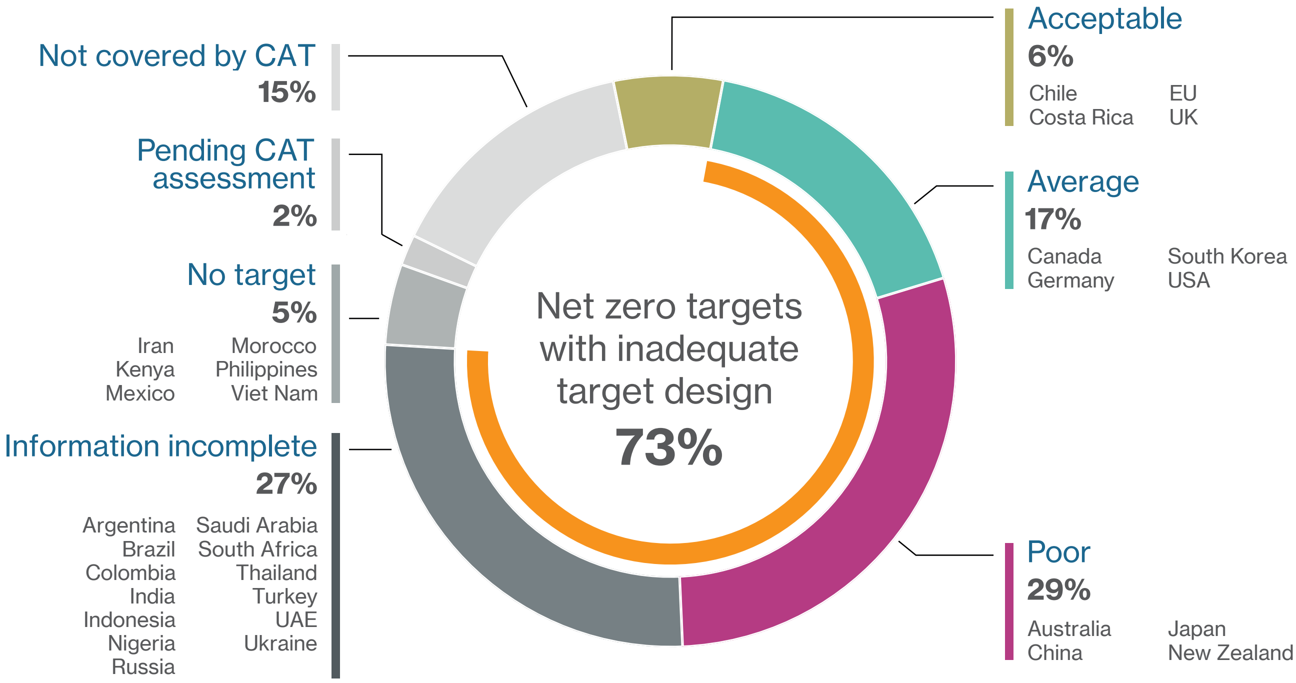
'Business-as-usual' scenario (highest warming)

If the NDCs that have been set by governments are not met, then the projected median level of warming for the planet is 2.7°C, based on analysis by CAT. The increasing use of natural gas and the fact that coal remains in the pipeline for a number of countries means this scenario is reasonably likely. Add to this the observation that 73% of net zero targets have inadequate target design, and it is clear that current policies place the world on track for global temperature increases of well above 1.5°C.[29]

At a temperature rise of 2.7°C the IPCC has reported a number of predicted physical impacts. These range from simultaneous crop failures in breadbasket regions across the world to a projected increase, regionally and globally, in diseases such as malaria, dengue, Lyme disease, and West Nile fever.[30] A simultaneous crop failure would have significant ramifications for feeding humans globally but also livestock and the production of biofuels. A world with an increase in infectious diseases would see a higher rate of mortality and lower quality of life, both within and outside traditional disease hotspots.

Figure 3 – **Net zero target design – mostly inadequate to date.**

Evaluation of the quality of net zero targets using the CATs design blueprint for transparent, comprehensive and robust national net-zero targets



Source: "Glasgow's 2030 credibility gap: net zero's lip service to climate action", *Climate Action Tracker.*

In practice

According to analysis by CAT, China's policies and action are "insufficient".[31] This is because even though China is close to meeting its "most binding existing and proposed NDC targets", current policy projections are still on track for a 20-25% increase in GHG emissions from 2010 levels by 2030.[32] This is evidenced by the increase in coal and gas consumption and cement and steel production following the presentation of its COVID-19 economic recovery strategy. This is despite the strategy having a stated emphasis on low-carbon growth. China has not committed to a net-zero by 2050 target instead aiming for "carbon neutrality by 2060".[33]

[29] "Glasgow's 2030 credibility gap: net zero's lip service to climate action", *Climate Action Tracker.*
[30] Portner et al., *IPCC WGII Sixth Assessment Report: Technical Summary,* p. 41.
[31] "China: Country summary", *Climate Action Tracker*, last modified May 19, 2022.
[32] "China: Country summary", *Climate Action Tracker*.
[33] "China: Country summary", *Climate Action Tracker*.

Which scenario is most likely?

The climate scenarios mentioned previously, and others predicted by the world's leading scientists, show that there is an inverse relationship between future expected warming and the magnitude of policy and other mitigation efforts. This highlights that there is no future without impacts from climate change. Instead, there will either be material effort towards the transition and a low expected temperature increase, with associated constrained damages from physical risks, or low effort towards the transition and a high expected temperature increase, with associated increased damages from physical risks.

This point is illustrated in the chart below produced by the Network for Greening the Financial System (NGFS) which presents a range of future climate scenarios that span the potential space of outcomes defined by level of ambition, speed, and efficacy of policy outcomes. The point to note from the table below is that there are no scenarios that exhibit both lower physical and transition risk.

There are two additional issues that are material to accurately assessing the likelihood of the future of the planet.

"... there is no future without impacts from climate change."

Historical underestimations

Historically, many climate scientists' predictions have been conservative, and effects of climate change have occurred sooner than expected or on a larger or more intense scale.[34] This is because climate scientists will often discount any uncertainty as they desire to focus on the assertions where there is the greatest confidence, in part due to political lobbying and politicisation. This leads to climate scenarios that do not consider, or underplay, outcomes, such as tipping points and feedback loops, where one negative effect worsens itself or another. There is a growing body of research into understanding climate tipping points which is helping to advance projections of future physical impacts and temperature rise as well as bolster the economic case for action to avoid the worst climate impacts (see Section 2 which explores tipping points).[35]

In short, this historical underestimation implies two things. First, it increases the likelihood of the business-as-usual, or higher warming, scenario. Second, it is likely to mean that the likely temperature outcomes in these scenarios also increase, and that physical impacts at a given level of warming will likely be significantly worse than previously suggested.

Table 1 – **A range of future climate scenarios**

		Physical risk	Transition risk			
Category	**Scenario**	**Policy ambition**	**Policy reaction**	**Technology change**	**Carbon dioxide removal**	**Regional policy variation**
Orderly	Net Zero 2050	1.5°C	Immediate and smooth	Fast change	Medium use	Medium variation
	Below 2°C	1.7°C	Immediate and smooth	Moderate change	Medium use	Low variation
Disorderly	Divergent Net Zero	1.5°C	Immediate but divergent	Fast change	Low use	Medium variation
	Delayed transition	1.8°C	Delayed	Slow/Fast change	Low use	High variation
Hot House World	Nationally Determined Contributions (NDCs	~2.5°C	NDCs	Slow change	Low use	Low variation
	Current Policies	3°C+	None – current policies	Slow change	Low use	Low variation

Colour coding indicates whether the characteristic makes the scenario more or less severe from a macro-financial risk perspective:

■ Lower risk ■ Moderate risk ■ Higher risk

Source: NGFS, NGFS Climate Scenarios for central banks and supervisors, 2021, p. 9

[34] Philip Bump, "You should not be surprised that climate predictions may have been too conservative", *The Washington Post*, July 19, 2021.
[35] Jim Skea et al., Climate Change 2022: Mitigation of Climate Change, (Geneva: IPCC, 2022), p. 1- 45.

Political lobbying

Political lobbying has, to date, played a large part in inhibiting action on climate. The latest IPCC report was delayed as governments debated with scientists about what to include in the summary for policymakers.[36,37] The IPCC report provides the foundation for all climate policy worldwide and is just one example of where the global messaging on climate is subject to political lobbying, with fossil fuel and meat producing countries lobbying against climate action.[38] Global cooperation efforts for action on climate are also heavily subject to lobbying. At the United Nations Climate Conference, COP26 in 2021, India applied pressure to weaken language about "moving beyond coal" and instead the "Glasgow Climate Pact" included a call to "phase down" coal use.[39] This has meant less pressure on countries to set ambitious policies to phase out coal.

Corporate lobbying within nations is not covered in this paper, but it would seem reasonable to assume that it is occurring, and that it is designed to protect current, rather than future, interests. Additionally, the continuation of national and corporate lobbying will likely raise the probability of the business-as-usual scenario.

Climate tipping points – "are thresholds where a tiny change could push a system into a completely new state".[40] For example, permafrost loss in the Arctic leading to a swift increase in GHG emissions.

Feedback loops – "the equivalent of a vicious or virtuous circle- something that accelerates or decelerates a warming trend. A positive feedback accelerates a temperature rise, whereas a negative feedback decelerates it".[41] For example, ice sheets which normally reflect heat back into the atmosphere are melting and expose more water which absorbs the heat and means that more ice is likely to melt.

[36] Hans Portner et al., IPCC WGII Sixth Assessment Report: Technical Summary.

[37] Fiona Harvey, *"IPCC report: 'now or never' if world is to stave off climate disaster"*, *The Guardian*, April 4, 2022.

[38] Lawrence Carter and Crispin Dowler, "Leaked documents reveal the fossil fuel and meat producing countries lobbying against climate action", *Unearthed*, October 21, 2021.

[39] Simon Evans et al., "COP26: Key outcomes agreed at the UN climate talks in Glasgow", *Carbon Brief*, November 15, 2021.

[40] "Explainer: Nine 'tipping points' that could be triggered by climate change", *Carbon Brief*, last modified 2020.

[41] "What are climate change feedback loops?", *The Guardian*, January 5, 2011.

Insight: Path dependency and the flow of time

It is useful to complement the analysis above with a more conceptual or theoretical angle. All the analysis presented is derived from models which have made projections into the future. This raises a number of issues, many of which are considered at different points in this paper. Here we consider two closely related points, path dependency and the flow of time.

A close reading of the text above will have revealed some clues regarding what kind of output the models are producing. For example, the 'business-as-usual' scenario was described as having a "median" temperature rise of 2.7°C, within a "range" which went up to 3.6°C. Similarly, the WMO has reported a "48% chance" of a single year in the next five being 1.5°C hotter. Both of these tell us that the underlying models are projecting forward multiple possible paths that the world might take. Those multiple paths fan out to produce a range of better-to-worse outcomes at different points in the future.

In a sense, the models are contravening a bedrock physical law – that time flows in one direction. Having projected out the first possible path, the model rewinds time to the starting point and heads back out into the future with the second path. It repeats this process as many times as it is asked to. This is fine for a model, and it is a very valuable learning tool for a human, but it is essential to remember the difference between the model and reality.

Unlike the model, humans will tread the path from 2023 to 2100 but once. In 2100 the world will be 1.5°C hotter; or 1.9°C hotter; or 2.4°C hotter; or some other value. But there will be no range, or average result. We won't be able to rewind, tweak a variable of two, and generate a preferable outcome. When it comes to time, it doesn't matter what the models say. What matters are the day-by-day decisions that generate a single path to a single temperature outcome.

The related concept here is path dependency. The previous sentence started to describe the concept as "the day-by-day decisions that generate a single path". The more accurate description of path dependency is that the set of possible future paths forward depends on the path taken to the present point. Imagine the fan of possible future paths described above covering the 80 years or so to 2100. For the next five years the lines will be tightly bunched, and the range of temperature outcomes between lowest and highest will be very small. At face value it would be tempting to conclude that it doesn't really matter what we do over the next five years because it makes very little difference. Path dependency overturns this thought and suggests that it matters intensely what we do over the next five years.

For the final five years between 2095 and 2100 the fan of possible paths will cover a very wide range. In the 'business-as-usual' scenario the range covers 2°C to 3.6°C. What is unknown is the '75-year-path-dependent' range. Does the best outcome at the five-year point generate a future fan between 2.0°C and 2.6°C, while the worst generates a fan between 3.0°C and 3.6°C? Or are the comparable ranges 2.0-3.2°C and 2.4-3.6°C? Irrespective of the answer, path dependency shows that the decisions taken in the short term will determine what long-term outcome is possible. We only get to make those decisions once; we cannot go back and amend them.

Conclusion

To conclude this section, it is increasingly likely that the best-case outcome is a temperature rise of around 1.8°C, rather than the hoped-for 1.5°C. The physical impacts will be more numerous and more severe than 1.5°C. Current behaviour is not currently in line with this 'optimistic' scenario. If humanity continues along the path it is presently on, with policies currently implemented, the expected rise in temperature is 2.7°C within a potential range that extends beyond 3°C. If historical underestimations of climate change and its impacts and political lobbying are accounted for, there is danger that the 'business-as-usual' scenario will come to fruition. The authors of this paper believe that if humanity wishes to achieve well below 2°C warming, we must not only see full implementation of all announced climate targets by governments but also a recognition by the investment industry that this is an emergency, and we are part of the economic system that must address it.

"If humanity continues along the path it is presently on, with policies currently implemented, the expected rise in temperature is 2.7°C within a potential range that extends beyond 3°C."

Section 2: We have all the evidence we need to act

This section aims to counteract the temptation to wait until more is known, or to understand better. Given the climate emergency (see Section 1), even delaying our action will be costly (see Section 3). Thus, this section presents the extreme weather events of the last two years and takes a theoretical look at systemic risk and climate tipping points. The aim is to provide a deeper understanding and the evidence that extreme weather events at 1.2°C of warming have severe effects.

Recent extreme weather-related events (physical risks)

There is already overwhelming evidence that the climate is changing. Extreme weather events are occurring all over the world, more often and with greater impact. Humanity's ability to learn and adapt means that lives lost now tend to be much lower now than decades ago. However, insurance pay-outs are following an increasing trend reflecting the frequent breach of meteorological records.[42]

Heat, fires and droughts

Since the 1980s each decade has been warmer than the previous one, and the most recent seven years have been the seven warmest on record.[43] In the last three years record temperatures, droughts and wildfires have been experienced globally. The 2019-20 bushfire season was Australia's worst in history in terms of the area of land burnt (between 240,000km^2 and 340,000km^2), wildlife deaths (an estimated 500 million), and damage to the environment (including the permanent damage of remnant rainforest).[44]

> *"Extreme weather events are occurring all over the world, more often and with greater impact."*

Successive wildfire seasons on the west coast of the USA have also been record breaking. The seasons are growing longer, flames are getting taller, and mega blazes (>400 km^2) are becoming the norm. The total area burnt in 2021 was 31,000 km^2.[45] This is, with little doubt, connected to the fact that the American west has spent the last two decades in the most extreme megadrought in at least 1,200 years.[46] Fire records are also being repeatedly broken in Siberia. Here the carbon emissions from burning trees are compounded by methane emissions from melting permafrost. The lengthening of the Siberian fire season is partly due to fire 'over-wintering' as peat smoulders beneath snow cover.[47]

Global average temperature records have seen seven of the hottest years on record in the last seven years and new local temperature records have been set with increasing frequency in all continents. The planet had seen the emergence of the 'heat dome', where the atmosphere traps hot air in the same place for a protracted period. The North American Pacific coast witnessed a heat dome in June-July 2021, leading to numerous new local temperature records including the highest ever recorded in Canada (49.6°C).[48] It has been assessed as a one-in-1,000-year event, made 150 times more likely by climate change.[49] It has been blamed for sparking numerous large wildfires and was responsible for extensive crop damage.

In March-April 2022, springtime, there was a second heat dome across India and Pakistan. Not only were multiple local record-high temperatures experienced (for example 49.5°C in Nawabshah, Pakistan), but the heatwave was notable because of its duration, and because it was accompanied by a significant drought.[50] It occurred shortly before the wheat harvest, killing plants and materially reducing the yield of wheat, as well as affecting other crops.

---

[42] Worryingly, this trend can stop through the withdrawal of insurance coverage or the increase of premiums to levels that encourage people to not insure or move. Both of these have started to occur.

[43] The pattern of successively warmer decades is expected to continue. See "2021 one of the seven warmest years on record, WMO consolidated data shows", *World Meteorological Office*, January 19, 2022.

[44] "2019–20 Australian bushfire season", *Wikipedia*, last modified July 4, 2022.

[45] "What the numbers tell us about a catastrophic year of wildfires", *The Guardian*, December 25, 2021.

[46] "US west 'megadrought' is worst in at least 1,200 years new study says", *The Guardian*, February 15, 2022.

[47] Guillermo Rein and Xinyan Huang, "Smouldering wildfires in peatlands, forests and the arctic: Challenges and perspectives", Environmental Science & Health, (2021): p. 6.

[48] "2021 Western North America heat wave", *Wikipedia*, last modified July 1, 2022.

[49] Sjoukje Y. Philip, *Rapid attribution analysis of the extraordinary heatwave on the Pacific Coast of the US and Canada June 2021*, (World Weather Attribution, 2021).

[50] *"2022 heat wave in India and Pakistan"*, *Wikipedia*, last modified June 27, 2022.

Another major consequence of drought is water scarcity. In May 2022 Lake Powell, the second largest reservoir on the Colorado River, dropped to 24% of its full capacity and continues to shrink.[51] The Colorado River is a water source for 40 million people across the West Coast of the USA, including Los Angeles. Across the world in Italy a state of emergency was declared in July 2022 in five northern and central regions. This is the result of drought and a severe heatwave threatening agricultural supply, power and bringing the country's largest river to a 70-year low.[52] Severe drought is also affecting water sources in Somalia. As of April 2022, approximately 4.2 million people are facing "acute water shortages" as 80% of the water sources across the country dry up.[53] These are just three examples of a phenomenon that appears to be accelerating in impact and importance. Given the central importance of water for sustaining life, this is a risk to watch carefully.

Storms and hurricanes

Rising global temperatures are an equivalent way of saying that the planet is absorbing more energy. In particular warmer oceans cause rainfall and wind speeds to increase, making tropical storms more intense – although it may not increase their frequency. Globally, climate scientists cannot conclude that tropical cyclone activity has definitively increased from historic levels, however they are 'virtually certain' (>99% probability) that the frequency and intensity of the strongest tropical cyclones in the North Atlantic have increased since the 1970s.[54] In 2021 the North Atlantic had its third-worst hurricane season with 21 named storms. It was the sixth consecutive year with above-normal hurricane activity. In 2020, the worst year, there were 30 named storms, of which 11 made landfall in continental United States.[55]

As an example of the power of these storms, Hurricane Ida hit Louisiana in August 2021 causing a failure of the electric grid which left thousands of people without power for 10 days in dangerous heat. Ida then left a trail of destruction across the eastern US, culminating in flash flooding in New Jersey and New York City. Returning to India, May 2021 saw two cyclones make landfall, Tauktae and Yass. The storms brought heavy rainfall and flash floods, four-metre-high (13ft) waves, displaced over 200,000 people, and caused widespread infrastructure and agricultural damage.[56]

51 "As drought crisis deepens, government will release less water from Colorado River reservoir", *LA Times*, May 3, 2022.

52 "Italy Declares State of Emergency on Impact From Drought", Bloomberg UK, July 5 2022.

53 *Somalia Water Shortage Update*, 23 April 2022, (New York City: ReliefWeb, 2022).

54 "Global extreme events - Tropical storms" *UK MetOffice*, last modified 2022. (Drawing on the 5th assessment report of the IPCC).

55 "Record-breaking Atlantic hurricane season draws to an end", *National Oceanic and Atmospheric Administration*, June 10, 2021.

56 "Cyclone Yaas: Severe storm lashes India and Bangladesh", *BBC News*, May 26, 2021.

Floods

The final area of extreme weather considered is flooding. While rising sea levels will become increasingly material over the decades to come, here the focus is on flooding due to rainfall.

In March 2021 on the east coast of Australia extreme rainfall led to widespread flooding in New South Wales, forcing 18,000 people to evacuate. The Australian government declared many parts of the east coast a natural disaster zone.[57] In April, Indonesia saw 500mm (nearly 20 inches) of rain in 48 hours, due to cyclone Seroja.[58]

In July 2021 London experienced flash flooding as 76mm of rain fell in 90 minutes.[59] However, it was eight countries in western Europe that were most severely hit in 2021, particularly Germany where the majority of deaths occurred. It has been described as one of the biggest natural disasters to hit the region and it led to widespread power outages, evacuations and damage to infrastructure and agriculture.[60]

In February 2022, east Australia experienced one of the nation's worst flood disasters stretching from Brisbane to Sydney. In the three days to 28 February, greater Brisbane received 676mm of rain, the largest three-day (and seven-day) total ever recorded.[61] In addition to the impacts noted above, in other geographies, food shortages were reported across regions due to supply chain problems. Across the world, heavy rains in Columbia caused a deadly mudslide.[62]

In April 2022 in Durban, South Africa days of heavy rain caused one of the country's deadliest natural disasters. There was extensive damage to important infrastructure which both affected access to one of South Africa's busiest ports, and hampered recovery and relief efforts.

Extreme weather summary

Common to every event mentioned above is the loss of human life. Another common thread is the impact on agriculture. In almost every case there was a negative impact on food production, and in some cases materially so.

In Section 1 it was suggested that the best-case outcome for the world is increasingly looking like 1.8°C with a rising probability of an outcome nearer 3°C if serious action is not taken. The events described here are associated with 1.2°C of warming. Future extreme weather events will be associated with a planet storing considerably more heat energy. It is therefore reasonable to expect even greater negative impacts on food production, even as the global human population continues to increase.

> *"Future extreme weather events will be associated with a planet storing considerably more heat energy. It is therefore reasonable to expect even greater negative impacts on food production ...."*

57 "2021 Eastern Australia floods", *Wikipedia*, last modified June 3, 2022.

58 Richard Davies, "Indonesia and East Timor – Flood Death Toll Climbs, Thousands Displaced", *FloodList.com*, April 7, 2021.

59 "A retrospective look at London surface water flash floods", *JBA risk management*, last modified July, 2021.

60 "2021 European floods", *Wikipedia*, last modified June 23, 2022.

61 "2021 European floods", *Wikipedia*.

62 "Colombia – Heavy Rains Trigger Deadly Mudslide in Risaralda", *FloodList.com*, February 9, 2022.

Insight: What is going on here?

We are tempted to ask, "how much more evidence do we need to start acting?" but that would imply we have just provided conclusive proof. For us, given our beliefs about climate change, the above narrative and the other events we observe month by month is sufficient evidence for action. However, let's switch focus and briefly explore a couple of useful underlying theoretical concepts before reaching any conclusion.

Systemic risk

A systemic risk is a risk that impairs the functioning of the system. The impairment could range from local inconvenience all the way through to a collapse of the entire system. Systemic risks are always with us and are not distinct events. They are 'endogenous' (that is they originate from within the system), and the probability of a systemic risk rises and falls through time depending on how we influence the evolution of the system.

What is new here is the need to adopt systems thinking. With systems thinking we are no longer solely concerned with the risk to, or failure of, a component, but with the interconnectedness of that component with the rest of the system. Does the failure propagate through the system, or remain local? As an example, consider the global financial crisis. It could be argued that this is the closest humanity has got to a failure of the entire financial system. Individual mortgage defaults were amplified through securitisation vehicles, which blew up many off-balance sheet vehicles, which caused problems for the balance sheets of banks. These were either allowed to fail (e.g. Lehmans) and cause extreme market volatility, or were bailed out by taxpayers and the pumping of central bank liquidity on a scale never before imagined. Without the taxpayer bailouts, it is completely plausible that the banking system would have failed and, with it, the payments system – with consequences for the receipt of wages and pensions and the purchase of food and other essentials.

It is worth sitting with that thought for a while. It isn't easy to imagine our entire system ceasing to function. And are we really claiming a bunch of bad weather could do that?

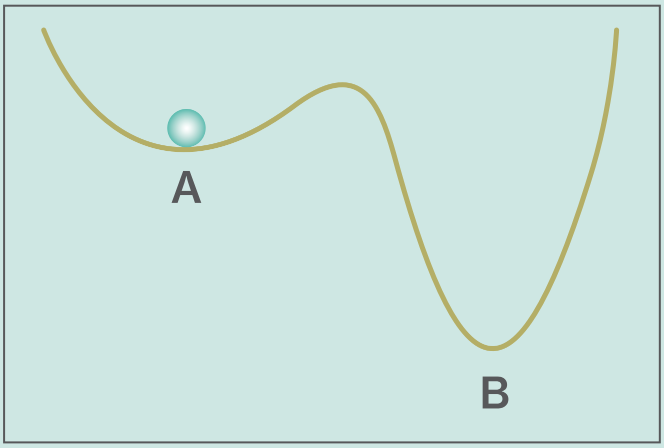
Well, yes... Here we will re-introduce the notion of climate tipping points.

Before we do so, we note that all the reports we have drawn from use integrated assessment models – a class of models that attempt to integrate a changing climate with an evolving economy via a 'damage function'. It is relatively straightforward to criticise the models, the assumptions used, and the resulting outputs, and we have done just that elsewhere.[63] Here we want to note that the models do not incorporate the notion of tipping points.[64] We will seriously underestimate the risk climate change poses if we ignore these tipping points.[65]

Climate tipping points

As an illustration of a tipping point, consider the sketch in the figure. The ball is in equilibrium at point A, but if we disturb the system (apply energy) we will cause the ball to roll from side to side around point A. If we apply more and more energy, eventually we will cause the ball to tip out of the basin around A and it will fall to point B. That becomes the ball's new equilibrium state. Technically this tipping point is not irreversible. With enough energy we could move the ball up its new left-hand side and tip it back into state A. However, the energy required to do this is much greater than the energy required to move from A to B. We don't know enough about climate tipping points to comment usefully on reversibility. We therefore invoke the prudence principle and state that it is much better to avoid tipping the system in the first place.

Figure 4 – **Tipping point illustration**



[63] Timothy Hodgson, "Climate tipping points change everything", *Thinking Ahead Institute*, March 22, 2022.

[64] The seminal paper on the subject is- Timothy M. Lenton, Hermann Held, Elmar Kriegler and Hans Joachim Schellnhuber, "Tipping elements in the Earth's climate system", *PNAS*, no. 6 [105] (February, 2008).

[65] Stephen Keen et al., "Economists' erroneous estimates of damages from climate change", *The Royal Society Publishing*, (August, 2021).

A climate tipping point is where a small change in the climate (usually global warming) triggers a qualitative change in part of the climate system[66] (state B feels noticeably different to state A). Large parts of the climate system that can pass tipping points are called 'tipping elements'[67], and it is also possible to tip the entire climate system.[68] The most policy-relevant tipping points are those that are likely to occur this century due to human activity, and that result in significant damages. They are (cryosphere) the melting of the Greenland, West and East Antarctic ice sheets, (circulation) the collapse of the Atlantic Meridional Overturning Circulation (AMOC), disruption of the West African and South Asian/Indian monsoons, and (biosphere) the large-scale dieback of the Amazon rainforest and boreal forests. Forest dieback could be near term and rapid,[69] while the melting of the ice sheets will take centuries to complete. The collapse of a monsoon system could be very fast and therefore devastate food production for hundreds of millions of people.

The scientific assessment of climate tipping points has changed over time. When first considered by the IPCC 20 years ago they would have qualified as extreme risks – only likely if there was no mitigation and temperature was allowed to increase by 4°C or more. Now they are considered to have a significant probability at current warming levels and a high probability at 2°C or above.

Further, the crossing of one tipping point can trigger a cascade of further tipping points. For example, the collapse of the AMOC would fundamentally change the European climate, raise sea levels in the North Atlantic by 1m, and disrupt monsoons around the tropics.[70] Can we predict how close we are to climate tipping points? Not really, because pre-tipping the observed changes tend to be smooth. When we observe abrupt changes, we have passed the tipping point.

The conversation about climate tipping points is a conversation about taking a climate system that has provided a pleasant niche in which humans have thrived, and moving it into a new state – hotter, more dangerous and less pleasant – with no path back. We have been living in an era of human-caused climate change (global warming). This is the good news, because if we have been causing it, we can stop causing it and there is a path back to the old, pleasant and less-dangerous niche. However, if we continue to force the climate system to warm, and we trigger a tipping point then we pitch ourselves into a new era. In that era, climate change will be partly human-caused and partly nature-caused. This is bad news, because we could drop our emissions to zero but we will not, then, be able to persuade nature to 'un-tip' herself. There will be no path back to our pleasant niche. This calls for grown up risk management, which in turn distinctly calls for sharp thresholds to be built into our models' damage functions – even if we don't have the first clue as to how punitive to make them.

Conclusion

This section reviewed a subset of the world's extreme weather events that have occurred in the last two years. These events were associated with approximately 1.2°C of warming. Even if humanity stopped all new emissions from today onwards, the planet will continue to get hotter. If humanity continues emitting along "business as usual" pathways, then the degree of warming will be worse. A warming world will cause increasingly severe extreme weather events. Further, the consequences of those events will fall disproportionately on the poor and those least able to withstand them.

A warming world raises the importance of systemic risk. It doesn't mean systemic risk inevitably rises, which will be the result of our response. However, it does mean the stakes are raised, and the possibility of 'falling behind the curve' increases. In addition, a warming world increases the risk of passing a climate tipping point.

The authors of this paper believe that humanity has all the evidence needed to act. The investment industry does not need more data, nor does it need more accurate models. The industry already understands well enough how to influence our system in order to manage down the systemic risk of climate change.

"Even if humanity stopped all new emissions from today onwards, the planet will continue to get hotter."

[66] We suggest the best explanation (short and simple) from a climate scientist is- Tim Lenton, "Tipping points in the climate system", *Global Systems Institute*, no. 10 [76] (August 2021).

[67] Lenton, Held, Kriegler and Schellnhuber, "Tipping elements in the Earth's climate system".

[68] Such as the on-set of ice-age cycles 2.5m years ago- see Tim Lenton, "Tipping points in the climate system".

[69] In- Alexandra, Heal, "Amazon rainforest is losing its ability to recover from destruction", *Financial Times*, March 7, 2022. Alexandra Heal reports that the tipping point could be as little as 10 to 20 years away.

[70] The currents are already at their slowest in the last 1,600 years, see- "Climate crisis: Scientists spot warning signs of Gulf Stream collapse", *The Guardian*, August 5, 2021.

Section 3: Reframing the transition as a net benefit

In the next century humanity will live through what will likely be the biggest transition the world has ever seen. There will be a transition of the economy, the climate, or some combination of both. This transition will involve cost. The investment industry and other key participants will either make productive investments now to build a new economy, which will make our current economy obsolete, or the cost will be incurred in the future to protect humans against a more dangerous environment.

There is an inverse relationship between efforts to transition the economy and anticipated temperature rise. Greater effort now is expected to result in a lower temperature rise and less severe associated physical risk outcomes. The IPCC advocates for all-out effort immediately to have any chance of limiting warming to a maximum of 1.5°C temperature rise, which it regards as necessary for long-term human safety. Many believe this outcome is no longer realistically possible, as the rapid transformation required to meet 1.5°C isn't palatable in key sectors and economies and may cause significant disruption.

Currently, there is a gap between what governments, investors, corporates and other sectors are communicating and what is actually being implemented. The combination of all announced net-zero pledges, long-term strategies and NDCs are consistent with a 1.8°C rise in temperature.[71] What is practically being implemented is more consistent with a 2.7°C (or more) rise.[72] The clinching factor in practical application is most often cost. To discern whether taking action to transition the economy now is beneficial, this section compares the economic cost of acting versus the cost of not acting.

Economic cost benefit analysis

As noted previously the costs that will be borne in the event of climate action and an economic transition, or inaction and a climate transition, are fundamentally different. In the case of climate action, the primary economic costs will be associated with transition risks whereas in the case of climate inaction physical risks will dominate. One of the challenges of the economic cost-benefit analysis of climate action versus inaction is the reality that the costs associated with transition and physical risks will manifest over very different time horizons.

The incremental economic costs associated with transition risk, enacted in order to mitigate future physical risks, will be borne now and each year over the coming decades. As decisive action is taken to transition critical economies this will result in the destruction of certain business models and the creation of new ones. Conversely, the incremental economic costs associated with physical risks will only start to be borne several decades into the future as the warming occurs with a lag of two, or more, decades. Future warming is already "baked in" by GHG emissions released in the past.[73]

" In the next century humanity will live through what will likely be the biggest transition the world has ever seen."

[71] "The CAT Thermometer", *Climate Action Tracker*.

[72] "The CAT Thermometer", *Climate Action Tracker*.

[73] This can be seen in the limited divergence between projected temperatures over the next 10- 20 years under the various scenarios as can be seen, for example, in the first part of the Sixth Assessment Report, Climate Change 2021: The Physical Science Basis released by the IPCC.

One way to assess whether investing in a way that furthers the transition to a well below 2°C world is a net benefit or a net cost is to compare the potential impact on current asset prices if the future incremental costs of action or inaction on climate were to be taken into account by markets.[74] This framing is consistent with the fact that the majority of investors have their primary objectives set in financial risk and return terms or perceive that fiduciary duty requires them to maximise risk-adjusted returns in financial terms.

The analysis below therefore uses established methodologies to project the expected costs of climate action and inaction. It then translates these into a corresponding permanent reduction in current global equity prices as a proxy for the impact on global asset markets. It is recognised that this analysis is based on a series of assumptions and as a result the likely skew of outcomes, relative to the figures presented, is also addressed.

Cost of inaction

As previously noted a 'business-as-usual' scenario, which can be interpreted as being insufficiently active on climate, is expected to result in a global average temperature increase in the range of 2.0-3.6°C, with a median projected increase of 2.7°C.[75]

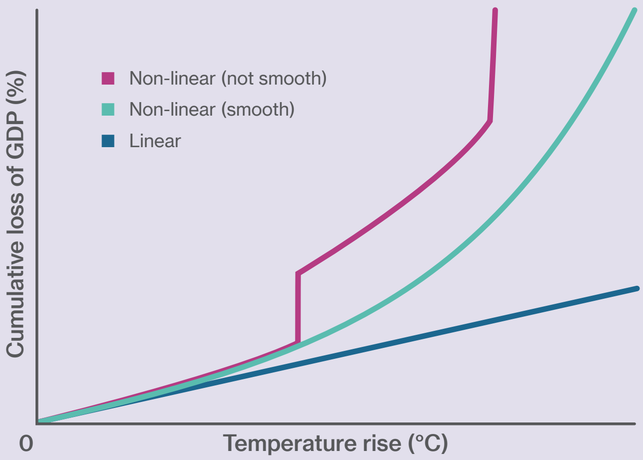
Burke et al. (2015) developed a model combining "historical evidence with national-level climate and socioeconomic projections" to estimate potential future economic damages associated with global warming.[76] This model makes some allowances for non-linear relationships between temperature increase and economic losses. However, the relationships are still assumed to be 'smooth', and the model does not capture potential climate tipping points.

Explained: Non-linearities (and smoothness)

Imagine an x-y chart, the x axis is temperature rise (which starts at 0°C), the y-axis is cumulative percentage GDP loss (which starts at 0%). A straight line from bottom-left to top-right is a linear relationship – each 0.1°C rise in temperature causes the same percentage loss of GDP. A curved line starting bottom-left and getting steeper as it moves right is a non-linear (and smooth) relationship – each successive 0.1°C rise in temperature causes a bigger and bigger loss in GDP.

Now imagine a third line: it curves up between +1°C and +2°C but then goes vertical for 10% of GDP before curving gently up between +2°C and +3.5°C where it shoots vertical again for 25% of GDP. Two separate 'step functions' have been introduced. The relationship is non-linear, but now it is also 'not smooth'. The third line effectively says, "there is a climate tipping point (as far as GDP is concerned) at +2°C, and another one at +3.5°C". We can imagine this could be the case, but we cannot infer it, or forecast it with certainty – we would have to wait for the empirical data to unfold.

Figure 5 – **Non-linearities (and smoothness)**



[74] In doing this we assume that the transition risks arising from a current policies scenario are in aggregated priced into markets – noting that a foundational belief embedded in our model is that markets are broadly efficient. We believe this is far less likely to be the case for physical risk given the analytical challenges. The physical consequences of global warming will grow over time, are subject to uncertainty (e.g. will the Gulf Stream change or not?) and will not be uniform across the globe. A proper evaluation of the physical risk of a security is complex and requires an understanding of the key operational locations (either directly owned or in the supply chain) producing the cashflows that underpin the value of these securities and any mitigation to these risks provided by insurance coverage. Investors ultimately make allowance for such risks in their security valuations through the use of an appropriate risk premium in the discount rate. This both provides a margin of safety for returns in the event that cashflows disappoint and also mechanically reduces the impact of longer-term events on the present value of the security.

[75] "The CAT Thermometer", *Climate Action Tracker*.

[76] Marshall Burke, W. Matthew Davis and Noah S. Diffenbaugh, "Large potential reduction in economic damages under UN mitigation targets", *Nature,* (2018): p.1.

Table 2 – **The impact on annual and cumulative trend real GDP**

	To 2050		To 2100	
	Impact on trend real GDP, pa	Cumulative income loss	Impact on trend real GDP, pa	Cumulative income loss
United States	-0.1%	-3.5%	-0.2%	-16.3%
China	-0.3%	-12.5%	-0.8%	-48.8%
Germany	-0.1%	-2.8%	-0.2%	-13.4%
United Kingdom	-0.1%	-2.4%	-0.1%	-11.4%
Australia	-0.1%	-2.7%	-0.2%	-12.7%
Japan	-0.1%	-3.1%	-0.2%	-14.8%
India	-0.3%	-9.6%	-0.6%	-39.3%
Bangladesh	-0.2%	-8.6%	-0.5%	-35.7%
Nigeria	-0.2%	-8.8%	-0.5%	-36.3%
World	-0.1%	-3.8%	-0.2%	-16.3%
Developed	-0.1%	-3.1%	-0.2%	-14.8%
EM	-0.2%	-5.7%	-0.4%	-21.9%

Economic impact of projected warming[77]

Note: table shows the impact on annual and cumulative trend real GDP, based on a temperature pathway consistent with the IPCC's RCP4.5 scenario and a growth pathway consistent with SSP2 (it's "middle of the road" economic pathway), relative to an RCP2.6 scenario.

Applying this methodology suggests that a 2.0-3.6°C temperature rise is projected to lead to a cumulative reduction in GDP of around 15-20% by 2100 relative to the optimistic scenario described previously.[78] Importantly this represents a permanent loss in output and income as opposed to a temporary reduction in GDP that would be observed during the trough of the business cycle but is later recovered. A further breakdown of this by country is provided in the table below, based on the median global average temperature increase of 2.7°C quoted by Climate Action Tracker (CAT). It clearly shows that more vulnerable nations will be disproportionately affected.

A 15-20% cumulative reduction in GDP can be thought of as the cost of inaction – the potential future economic damages from physical climate risks. This would translate to equity prices being permanently 10% lower[79] than they are today.[80]

Cost of inaction is likely skewed to the downside

However, it is highly likely that economic models quantifying the relationship between temperature rise and GDP loss significantly underestimate the economic costs of climate change.

There are a number of studies that predict the relationship between temperature and GDP loss. These studies predict a range of economic impacts with the differences accounted for by; the modelling approach, the correlation between impacts and growth rate, and adaptation response.[81] The models often assume that GDP will continue to grow into the future at current growth trend rates, irrespective of how high temperatures climb (see box on discount rates). This assumption does not seem reasonable given the potential economic damages arising from physical climate risks.

"… it is highly likely that economic models quantifying the relationship between temperature rise and GDP loss significantly underestimate the economic costs of climate change."

77 WTW analysis based on- Marshall Burke, Solomon M. Hsiang and Edward Miguel, "Global non-linear effect of climate change on economic production", Nature, (2015).

78 Burke, Davis and Diffenbaugh, "Large potential reduction in economic damages under UN mitigation targets".

79 This figure assumes a 6% discount rate and that, broadly speaking, 1% pa reduction in GDP growth translates to a 1% pa reduction in corporate revenue growth.

80 Although this level of downside appears relatively small compared to the typical volatility of equity prices, it should be noted that this represents a permanent loss of future income/permanent impairment of capital. Whereas marked to market equity volatility also captures factors such as temporary losses of income and changes in market sentiment/"noise".

81 NGFS, *NGFS Climate Scenarios for central banks and supervisors*, (Paris: 2021), p. 41.

The models also include several assumptions and contains gaps. For example, the models assume "that socioeconomic factors such as population, migration and conflict remain constant even at high level of warming".[82] Additionally, few models fully capture tipping points and associated physical risks, which can be irreversible, for example Amazon rainforest dieback (see Section 2).

Furthermore, the ramifications of reaching each tipping point on other tipping points are uncertain, a concept called "tipping cascades". As such it is suggested that the social cost of carbon (SCC) calculated using these models could actually be more than eight times higher and that beyond a 2°C temperature rise tipping cascades could occur.[83,84,85]

The result of these modelling underestimations is that the costs of inaction on climate change and the risk of disruption from climate impacts has been "systematically downplayed".[86] If the presence of tipping points means that economic damages could be eight times higher than predicted by conventional economic models this would change the previous estimate of a 10% permanent loss to equity values to a loss more like 50-60%.[87] This represents a significant potential downside to the value of existing financial assets resulting from inaction on climate issues.

Tipping cascades – occur when passing a threshold for one system – say, a temperature above which the Greenland ice sheet irreversibly shrinks – triggers causal interactions that increase the likelihood that other tipping elements undergo transitions. In this example, freshwater input to the North Atlantic increases the risk of a collapse of the Atlantic Meridional Overturning Circulation (AMOC), which increases the risk of interrupted monsoons and so on.[88]

Social cost of carbon (SCC) – is an estimate of the economic costs, or damages, of emitting one additional ton of carbon dioxide into the atmosphere. It therefore also quantifies the benefits of reducing emissions. Governments and international organisations, such as the IMF, employ economists to calculate the SCC and use it to calculate the optimal carbon price.

82 NGFS, *NGFS Climate Scenarios for central banks and supervisors*, p. 41.

83 Keen et al., "Economists' erroneous estimates of damages from climate change", p. 4.

84 Dietz et al. has suggested that climate tipping points could increase the SCC substantially. See- Simon Dietz, James Rising, Thomas Stoerk and Gernot Wagner, "Economic impacts of tipping points in the climate system", *PNAS*, no. 34 [118] (August 2021), p. 1.

85 Derek Lemoine and Christian P. Traeger, "Economics of tipping the climate dominoes", *Nature*, (January 2016), p. 1.

86 Keen et al., "Economists' erroneous estimates of damages from climate change", p. 27.

87 This is based on our own analysis.

88 Example from- Keen et al., "Economists' erroneous estimates of damages from climate change", p. 2.

89 Nicholas Stern, Joseph E. Stiglitz and Charlotte Taylor, "The economics of immense risk, urgent action and radical change: towards new approaches to the economics of climate change", *NBER working paper series*, (February 2021).

Explained: Discount rates and intergenerational equity

Most people are intuitively familiar with discount rates – if I am offered $100 today or $100 in one year's time, I will take the $100 today as I see it as more valuable. We can then play with the numbers. For example, I would take $110 in one year over $100 today. Somewhere between $0 extra and $10 extra will be a number where I am indifferent between the money today and the money in a year. This would be my private one-year discount rate.

From here we can extend the concept out in time. The longer I have to wait to receive $100 in the future, the less valuable it is to me today. It is perfectly reasonable to play around with my private discount rate. However, it is not reasonable to extend this beyond my lifetime. Who are we to judge how valuable a 20-year-old in 2070 will judge $100 to be, when it is to be received in 2100? Many economists and moral philosophers have argued that the only morally defensible intergenerational discount rate is 0%pa.[89] In practice, discount rates tend to be positive and then the argument is over "how positive?".

Why does this matter? We think for two reasons. The first is practical, because the chosen discount rate directly affects the calculated size of the social cost of carbon (SCC). For example, let's hypothetically assume that climate change will cause $100 of damage in 50 years' time. If we use a discount rate of 5%pa, then we are saying that this matters as much to us as $8.72 of damage today. If we use a discount rate of 1%pa the value today is $60.80. The Trump administration used a discount rate of 7%pa, yielding a SCC of $1. Following the arguments above, this is an inappropriate use of a private discount rate. In his seminal review,[90] Nicholas Stern suggested a social welfare discount rate of 1.4%pa. If we used this rate the SCC would be "in the thousands of dollars".[91]

The second reason the choice of discount rate matters is moral/ethical. In fact, the choice of the rate is intrinsically a moral decision as there is no objective method to derive it given a fundamentally uncertain future. The rate encapsulates how we have decided to treat future generations. The lower the discount the higher the value today of those future damages, and the greater the effort we must put in to prevent them. The higher the discount rate, the more we will leave future generations to repair the damage. A related point is that the models also assume economic growth will continue smoothly as far into the future as our modelling horizon. Under a changing climate, this assumption starts to look shaky. We believe that the warmer the world gets the more likely growth is to fall.

90 Nicholas Stern, *The Economics of Climate Change: The Stern Review*, (Cambridge: Cambridge University Press, 2006).

91 Sigal Samuel, "The Supreme Court just okayed Biden's "social cost of carbon." It's still way too low", *Vox*, May 27, 2022.

Cost of action

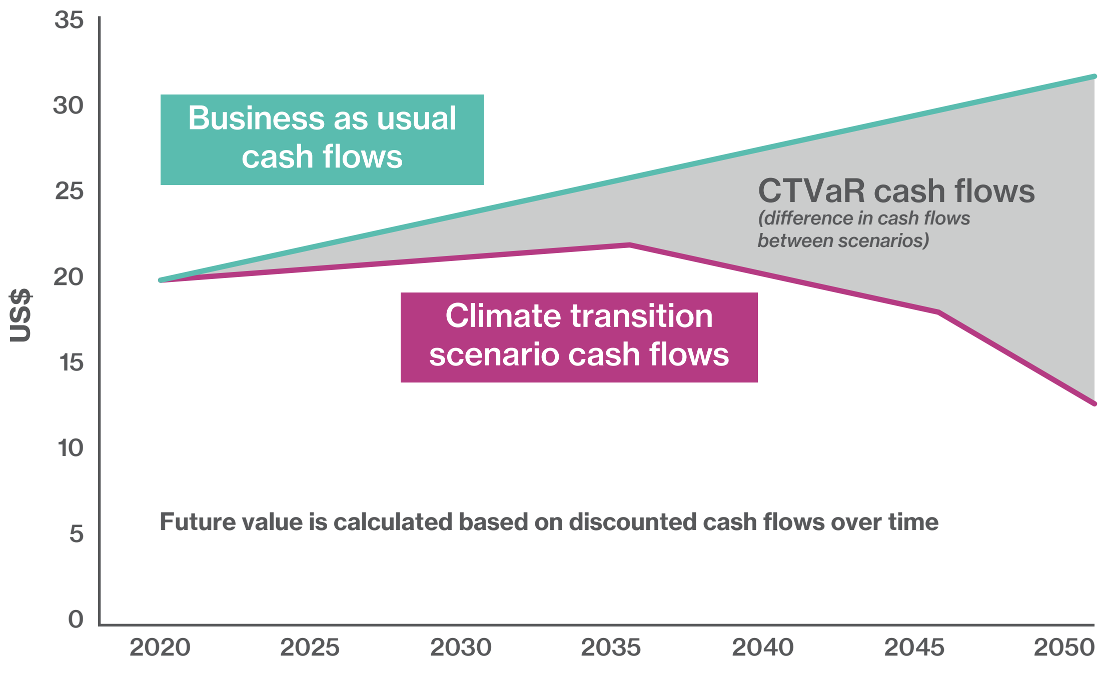
Similar to costs of inaction, if the investment industry acts there are costs to transition the economy. The actions relevant to the investment world broadly fall into the categories of new primary investment and influencing the capital allocation decisions of existing investee companies. The former is hard to model as it requires very granular assumptions about what new investment takes place, but intuitively it feels like the action is creating the transition. For the latter, assumptions can be made about how the future cashflows of the corporation will change, for example due to changes in policy and consumer demand. Even though action is taking place, intuitively it feels more remote – almost as if the transition is being done to us.

This said, it is possible for the investment industry to influence the pace of the transition by appropriately repricing assets to reflect a well-below 2°C world. One approach to do so is to consider the potential change in asset prices in the market as it moves to factor the policy, regulatory, technological, consumer and other shifts that are required. As was the case for the analysis of the cost of inaction this can similarly be expressed as a percentage change to current asset prices in net present value (NPV) terms.

One methodology that attempts to carry out this type of analysis is Climate Transition Value at Risk (CTVaR) developed by WTW which measures how a company's value would change if market expectations were to shift from "business as usual" to a full climate transition.[92]

Future cash flows are reflected in today's equity prices. If net-zero targets are met, it is assumed there will be changes in future corporate cash flows due to changes in policy, regulation, technology, and consumer preferences. This could lead, for example, to changes in commodity demand. If markets were to move to anticipate a climate transition as opposed to "business as usual" outcomes the value of companies would be adjusted depending on the path of the climate transition. The resulting estimate of CTVaR for global equity assuming a well below 2°C scenario is -3%. This means that the overall "cost" to current financial assets of transitioning the economy instead of the climate is around a 3% permanent reduction in equity values.

Figure 6 – **Cash flow illustration of negative CTVaR company**



Source: WTW, Quantifying the financial impact of the net zero transition

[92] Quantifying the financial impact of the net zero transition, WTW, (London: 2021), p. 13.

Organised transition – a "consistent, well-designed transition" scenario that "minimises the cost and economic inefficiency of the transition".[93]

Disorganised transition – a scenario that should "reflect the potential and likely paths that a transition could take" given uncertainties and responses to "politics, policy, technology, and consumer and investor behaviour".[94]

CTVaR assumes an organised, economically optimal transition. However, there are material risks of delayed action and policy slippage. This would increase the likelihood of a disorganised and non-optimal transition.

Policy slippage from unforeseen global events, such as war, may cause a diversion of resources away from the implementation of climate policies.[95] Policy slippage may also occur, and has historically, through changes in political control. For example, the United States filed its intent to withdraw from the Paris Agreement in 2019, withdrawing from the agreement in 2020, only to re-join in 2021.[96]

In addition, the climate transition is not a single global transition but is made up of a multitude of micro-transitions. Most scenarios are built on the assumption that the transition will occur simultaneously across sectors and geographies.[97] In reality the transition in some sectors, and geographies, will be swift and in others it will lag behind. Such factors mean that the likelihood of a transition being somewhat disorganised is relatively high.

A disorganised transition is, by definition, more disruptive and economically damaging than an organised transition. Analysis by MSCI suggests that the potential loss to global equities in the event of a disorganised transition to a well below 2°C world may be more than five times the loss that would be experienced under an organised transition.

Benefits of action also likely understated

It is also highly likely that the estimated benefits of action are biased to the downside. CTVaR and other similar approaches to quantifying transition risk look at the potential impact of action on existing financial assets. However, much of the action taken will be in the form of new primary investments, only some of which will be made by existing corporations. The providers of the financial capital will expect future returns after the initial drawdown (in industry jargon this is a "J-curve" cashflow profile). For the economy there will be an immediate boost from spending on wages and capital goods.[98] It can also be anticipated that the new goods, services, and underlying technologies will bring associated cost reductions and productivity boosts.[99]

There will be considerable new primary investment in renewable energy generation, and it is reasonable to expect a continued reduction in the unit cost of energy produced.[100] Additionally, energy infrastructure that is low carbon is less expensive to operate than coal and gas, where high temperatures and pressures cause wear and tear and parts can only be replaced by shutting the whole generator down. New primary investment will also be required to support the "greenifying" of production methods in key sectors such as cement and steel. Beyond this is the unmodelled boost to the value of human capital as cleaner air leads to fewer premature deaths each year.[101]

These associated benefits of new primary investment reinforce the fact that there are potential benefits from climate action that are unlikely to be fully captured in most approaches to quantifying transition risk.

"… there are potential benefits from climate action that are unlikely to be fully captured in most approaches to quantifying transition risk …"

93 "The risks from disorganised climate transitions", *WTW*, February 7, 2022.
94 "The risks from disorganised climate transitions", *WTW*.
95 Spencer Bokat-Lindell, "What the Ukraine War Means for the Future of Climate Change", The New York Times, March 16, 2022.
96 David Page, *The costs of climate change: Action versus inaction*, (London: AXA), 2021.
97 "The risks from disorganised climate transitions", *WTW*.
98 Assuming this new investment also increased investment in research and development we should also expect boosts to productivity and economic growth. See- *Investing in Climate, Investing in Growth: A Synthesis*, (Paris: OECD, 2017).
99 Page, *The costs of climate change: Action versus inaction.*
100 Page, *The costs of climate change: Action versus inaction.*
101 Max Rosser, "Data Review: How many people die from air pollution?", Our World in Data, last modified November 25, 2021.

Insight: The frame of reference matters

What is going on here? Why do so many smart economists believe that limiting global warming to +1.5°C is uneconomic? Especially when so many equally smart people struggle to see how it could possibly be economic to let temperatures run up to 3°C.

Our tentative answer is that it is to do with the medium we inhabit. To explain, consider the old joke about two young fish swimming along. Swimming towards them is an older fish who, on passing, greets them with "how's the water today?". After a while one of the younger fish turns to the other and asks, "what's water?". The point, of course, is that the medium we live in is largely invisible to us.

Economists, and those of us who work in finance, live 'in markets'. Or, more precisely, we live in a version of capitalism which places primacy on markets. We no longer see markets as a mere tool, that may or may not be useful for the task at hand. Markets just are. They are the water we swim in. It is unlikely that an artist or a zookeeper would view markets in the same way. They might even see markets as the problem.

Let's dive a little deeper. It was Friedrich Hayek who first described a market economy as an information processing system characterised by spontaneous order. This describes the economy as a complex system. Order emerges from the independent actions of billions of individuals, each with limited and local information. The information that the market processes is the set of prices which, in turn, reflect the multitude of independent actions.[102] It is then asserted that this leads to the optimal allocation of resources.[103] We can quickly knock this idea down, because we have been operating without a price for carbon emissions. The market has therefore been processing incomplete information, and consequently we cannot assume that the result is optimal. When we consider that it is not just a price for carbon dioxide that is missing, but also prices for methane, nitrous oxide, sulphur hexafluoride, nitrogen trifluoride, and multiple hydrofluorocarbons and perfluorocarbons, then we realise that our set of prices is seriously deficient, and we may not even be close to the optimal allocation. In fact, we can generalise this idea. Any identified externality is evidence of at least one missing price.

Now, let's try a brief thought experiment. Imagine that Adam Smith's Wealth of Nations had included a chapter on externalities and the necessity of a carbon price. We will assume that, after appropriate parliamentary debate, the UK had mandated a carbon price (and pre-emptive carbon border tax) in 1780. From this simple set-up, the questions flood out:

- Would we have run a net-zero economy from the start?
- How would this have affected economic development from then till now?
- How would it have affected human health and wellbeing?

There are no answers to these questions of course. But we suspect that economic development would have been 'cleaner' with positive effects on human health and wellbeing, but that the rate of growth would have been lower, yielding a smaller global economy.[104] It is possible that the artists and the zookeepers would see this as a preferable outcome.

From here, we can return to our medium. If we live 'in markets' then our purpose is to preserve and prosper the market system (that allowed us to accumulate financial capital). The biosphere is a tool that can help us to do that. If, however, we live 'in biology' then our purpose is to accumulate wellbeing, and the market economy is a tool we can choose to use, or not, if it helps us achieve that.

In this light, the arguments we have discussed above over models, costs vs benefits, and the correct temperature objective, seem to boil down to a rather simple question: what do we value most? Our economy (perhaps, deeper, our ideology) or our climate niche (perhaps, deeper, our sense of humanity)? If the former, then it is appropriate to sacrifice our climate niche, and 3°C is the better objective for us, if not for future generations. If it is the latter, then 1.5°C is the best-possible objective (0°C would be ideal), and we may need to retire, or strand, parts of our economy.

[102] Technically, the market solves jointly for price and quantity. Quantity is typically assumed to be freely variable – if the price rises it will cause more quantity to be supplied. We are currently receiving a lesson that this isn't always true. It doesn't matter how high the price of wheat goes, if stocks are trapped by war, or not replenished because of drought, quantity will not respond to the price signal.

[103] For the technically minded, the Arrow-Debreu 1954 paper could be considered a demonstration rather than an assertion – provided we can assume that 'markets are complete'. This is equivalent to saying that the set of prices is complete. We are about to argue that this is clearly not a reasonable assumption, and the consequences are enormous. See- Kenneth J. Arrow and Gerard Debreu, "Existence of an equilibrium for a competitive economy", *Econometrica*, no. 3 [22] (July 1954).

[104] By internalising externalities, profits would have been lower, meaning reinvestment rates and therefore compounding would have been lower.

Conclusion

The analysis presented above suggests that the potential cost to financial assets of climate inaction meaningfully exceeds the anticipated costs of taking action to drive an organised climate transition. Additionally, delaying action will lead to the cost of inaction increasing as this increases both the likelihood and magnitude of higher temperature scenarios, as well as the occurrence of the more severe physical risk outcomes becoming closer as time passes.

This is particularly the case when taking into account the presence of climate tipping points which means that the costs of physical climate risks are likely significantly understated by most economic models. Inaction on climate issues could see a 50-60% loss to existing financial assets, whilst taking action might lead to a 15% loss. Add to this the fact that most approaches to quantifying transition risk look at existing financial assets and do not fully consider the benefits of new primary investment and associated cost reductions and productivity boosts.

There are also environmental and social benefits to acting now, due to a reduction in negative externalities not factored into economic cost. These include but are not limited to health and wellbeing, populations not displaced and biodiversity benefits.[105]

Taken together it is clear that acting now will incur costs, but that these will be materially less than those arising from a late transition or no transition at all.

This said, it should also be noted that the costs of action presented are potentially understated with the potential for a disorganised transition driven by delayed action and/or policy slippage. This highlights the importance of not just taking action but also ensuring that climate action is aimed at stewarding as orderly a transition of the economy as possible. Investors can influence this transition.

"Inaction on climate issues could see a 50-60% loss to existing financial assets, whilst taking action might lead to a 15% loss."

[105] Page, *The costs of climate change: Action versus inaction.*

Conclusion and next steps

In this paper it has been evidenced that climate change is an emergency. It is clear that 1.8°C by 2100, not 1.5°C, is the most likely 'optimistic' temperature rise scenario.[106] It is also clear that if humanity continues along the 'business-as-usual' path, taking into account historical underestimations of climate change and political lobbying, there is a significant chance there will be a temperature rise of between 2.7-3.6°C. Thus, the choice is between an immediate and rapid transition of the economy to net-zero carbon, or a transition of the climate to a state that scientists have deemed unsafe. The concept of path dependency, and the reality that humanity can only run one path into the future, argue for fully committed action now.

The world is already experiencing warming of 1.2°C and the physical risk impacts, seen across the world, have been numerous and severe. The authors of this paper believe that if we also account for climate tipping points and the notion of systemic risk, it is clear that the effects of climate change are here now and that the investment industry has all the evidence needed to act.

Acting now will incur costs but these will be materially less than those arising from a late transition, or no transition at all. This is particularly acute if climate tipping points that would significantly magnify the costs of inaction, and the benefits of new primary investment that increase the payoffs to action are accounted for. It is important that this action is taken now and is aimed at stewarding a co-ordinated and orderly-as-possible transition of the economy, as a disorganised transition will be more costly and harmful. The authors of this paper believe that humanity must also make a choice about what is most valuable, the economy in its present form, or the climate in its present form, and the levels of wellbeing associated with each.

If humanity wishes to limit warming to well below 2°C, there must not only be a full implementation of all announced climate targets by governments but also a recognition by the investment industry that we are part of the economic system that must address it. Delaying action will lead to a higher cost for the economy and the climate, which not just the investment industry but all of society will pay for longer.

"If humanity wishes to limit warming to well below 2°C, there must not only be a full implementation of all announced climate targets by governments but also a recognition by the investment industry that we are part of the economic system that must address it."

[106] "The CAT Thermometer", *Climate Action Tracker.*

What actions can the investment industry take?

These actions lie beyond the remit of the paper. However, extensive research in this space has been carried out by the Thinking Ahead Institute (TAI) previously:

- A six-step action plan for net-zero – this paper sets out a framework to help asset owners establish and execute a pathway to achieve their climate ambitions.

- Investment beliefs to change the climate trajectory – this paper lays out six ambitious **climate beliefs** and the process it took to land on them. Investor actions are explored through beliefs 4-6 including: the **stop, substitute, siphon framework**, developing **new investment conventions**, and committing to **meaningful collaboration** (p. 18- 24).

- We've decided to address climate change: getting our own house in order – this paper presents **32 ideas for actions that asset owners can take** to implement their climate ambition. The first 16 actions relate to **decarbonising an organisation's own portfolio**, but also form a foundation for the second set of 16 actions which target **changing the climate trajectory**. The stop, substitute, siphon framework is outlined (p. 4 onwards).

- 3D net-zero mandates – this paper moves from an asset owner's internal **focus to looking at their external relationships** in the context of the net-zero transition. There is a focus on 3D investing (risk, return and impact) and the **management of 3D net-zero mandates** (p. 3 onwards).

- How much of the climate problem does the investment industry own, and what should it do about it? The answer is a lot more primary investment - This paper explores how much of the climate problem that the investment industry owns and advocates for more new, **primary investment** (p. 6 onwards).

- Beyond ESG: System solutions for sustainability – this lecture series with Duncan Austin reveals the innate limitations of our current effort to build a sustainable economy, exploring **systems thinking** as a way forward.

Appendix: Physical impact risks from global warming

The information in the table below is taken from the IPCC WGII Sixth Assessment Report's Technical Summary[107]

Warming level	Expected impacts
1.0 – 1.5°C	**Extreme weather events** ▪ increased heat-related mortality of humans ▪ agricultural and ecological droughts ▪ water scarcity ▪ short-term food shortages ▪ impacts on food security and safety, price spikes ▪ marine heat waves estimated to have doubled in frequency
1.2 – 2.0°C	**Threat to unique systems** ▪ coral reef decline by 70-90% at 1.5°C ▪ further decline of Arctic sea ice-dependant ecosystems ▪ insects projected to lose >50% climatically determined geographic range at 2°C ▪ reduced habitability of small islands ▪ increased endemic species extinction in biodiversity hotspots
1.5 – 2.0°C	**Impacts disproportionately affect particular groups, such as vulnerable societies and socio-ecological systems, including disadvantaged people and communities in countries at all levels of development** ▪ risk of simultaneous crop failure in maize estimated to increase to 40% ▪ increasing flood risk in Asia, Africa, China, India, and Bangladesh ▪ high risks of mortality and morbidity due to heat extremes and infectious disease with regional disparities
1.5 – 2.5°C	**Global aggregate impacts** ▪ estimated 10% relative decrease in effective labour at 2°C ▪ global exposure to multi-sector risks approximately doubles between 1.5°C and 2°C ▪ global population exposed to flooding projected to rise by 24% at 1.5°C and by 30% at 2.0°C warning ▪ reduced marine food provisioning, fisheries distribution, and revenue value with projected ~13% decline in ocean animal biomass
1.5 – 2.5°C	**Tipping points** ▪ implications for 2000-year commitments to sea level rise from sustained mass loss from both ice sheets as projected by various ice sheet models, reaching 2.3-3.1 m at 1.5°C peak warming and 2-6 m at 2.0°C peak warming ▪ risk of savannization for the Amazon alone was assessed to lie between 1.5 and 3°C with a median value at 2.0°C

[107] Hans Portner et al., *IPCC WGII Sixth Assessment Report: Technical Summary*, p. 40-42.

Warming level	Expected impacts
1.8 – 2.5°C	**Extreme weather events** ▪ significant projected increases in fluvial flood frequency and resultant risks associated with higher populations ▪ at least 1 day per year with a heat index above 40.6°C for about 65% of megacities at 2.7°C ▪ soil moisture droughts 2-3 times longer ▪ agricultural and ecological droughts more widespread ▪ simultaneous crop failure across worldwide breadbasket regions ▪ malnutrition and increasing risk of disease
2.0 – 3.5°C	**Impacts disproportionately affect particular groups, such as vulnerable societies and socio-ecological systems, including disadvantaged people and communities in countries at all levels of development** ▪ much more negative impacts on food security in low-to mid-latitudes ▪ substantial regional disparity in risks to food production ▪ food related health projected to be negatively impacted by 2-3°C warming ▪ heat-related morbidity and mortality, ozone-related mortality, malaria, dengue, Lyme disease, and West Nile fever projected to increase regionally and globally
2.5 – 4.0°C	**Tipping points** ▪ uncertainties in the projections of sea level rise at higher levels of warming, long-term equilibrium sea-level rise of 5-25 m at Mid-Pliocene temperatures of 2.5°C ▪ potential for Amazon forest dieback between 4-5°C ▪ risk of ecosystem carbon loss from tipping points in tropical forest and loss of Arctic permafrost
2.5 – 4.5°C	**Global aggregate impacts** ▪ widespread death of trees ▪ damages to ecosystems, and reduced provision of ecosystem services over the temperature range 2.5°C-4.5°C ▪ projected global annual damages associated with sea level rise of $31,000 billion per year in 2100 for 4°C warming scenario

Limitations of reliance

Limitations of reliance – Thinking Ahead Group 2.0

This document has been written by members of the Thinking Ahead Group 2.0. Their role is to identify and develop new investment thinking and opportunities not naturally covered under mainstream research. They seek to encourage new ways of seeing the investment environment in ways that add value to our clients. The contents of individual documents are therefore more likely to be the opinions of the respective authors rather than representing the formal view of the firm.

Limitations of reliance – Willis Towers Watson

Willis Towers Watson has prepared this material for general information purposes only and it should not be considered a substitute for specific professional advice. In particular, its contents are not intended by Willis Towers Watson to be construed as the provision of investment, legal, accounting, tax or other professional advice or recommendations of any kind, or to form the basis of any decision to do or to refrain from doing anything. As such, this material should not be relied upon for investment or other financial decisions and no such decisions should be taken on the basis of its contents without seeking specific advice.

This material is based on information available to Willis Towers Watson at the date of this material and takes no account of subsequent developments after that date. In preparing this material we have relied upon data supplied to us by third parties. Whilst reasonable care has been taken to gauge the reliability of this data, we provide no guarantee as to the accuracy or completeness of this data and Willis Towers Watson and its affiliates and their respective directors, officers and employees accept no responsibility and will not be liable for any errors or misrepresentations in the data made by any third party.

This material may not be reproduced or distributed to any other party, whether in whole or in part, without Willis Towers Watson's prior written permission, except as may be required by law. In the absence of our express written agreement to the contrary, Willis Towers Watson and its affiliates and their respective directors, officers and employees accept no responsibility and will not be liable for any consequences howsoever arising from any use of or reliance on this material or the opinions we have expressed.

Contact details

Tim Hodgson
tim.hodgson@wtwco.com

Isabella Martin
isabella.martin@wtwco.com

The Thinking Ahead Institute

About the Thinking Ahead Institute

Mobilising capital for a sustainable future.

Since establishment in 2015, over 80 investment organisations have collaborated to bring this vision to light through designing fit-for-purpose investment strategies; better organisational effectiveness and strengthened stakeholder legitimacy.

Led by Tim Hodgson, Roger Urwin, Marisa Hall and Paul Deane-Williams our global not-for-profit research and innovation hub connects our members from around the investment world to harnesses the power of collective thought leadership and bring these ideas to life. Our members influence the research agenda and participate in working groups and events and have access to proprietary tools and a unique research library.

Join the Thinking Ahead Institute

We seek collaboration with like-minded organisations to achieve our vision, so for more information about us please contact:

Paul Deane-Williams
+44 (0)7734 342139
paul.deane-williams@wtwco.com

About the Thinking Ahead Institute

The Thinking Ahead Institute seeks to bring together the world's major investment organisations to mobilise capital for a sustainable future. Arising out of Willis Towers Watson's Thinking Ahead Group, formed in 2002 by Tim Hodgson and Roger Urwin, the Institute was established in January 2015 as a global not-for-profit research and innovation group comprising asset owners, investment managers and service providers. Currently it has over 55 members with combined responsibility for over US$16trn.

Towers Watson Limited (trading as Willis Towers Watson) of Watson House, London Road, Reigate, Surrey, RH2 9PQ is authorised and regulated by the Financial Conduct Authority.

TAI-IC025/08/2022

thinkingaheadinstitute.org

Thinking Ahead Institute
An innovation network founded by WTW