Climate scenario analysis update 2022

The third year of our analysis shows warming beyond 2°C still to be expected

abrdn.com

May 2023

Contents

Key Takeaways	3
Our bespoke approach to climate scenario analysis	4
Updating our climate scenarios	5
Implications for the energy transition	10
Financial impacts on equity and fixed income: what has changed?	13
How do transition plans and our credibility assessment affect the climate scenario analysis?	23
Limitations	27
Appendix	28

Authors

Anna Moss
Senior Sustainability Analyst

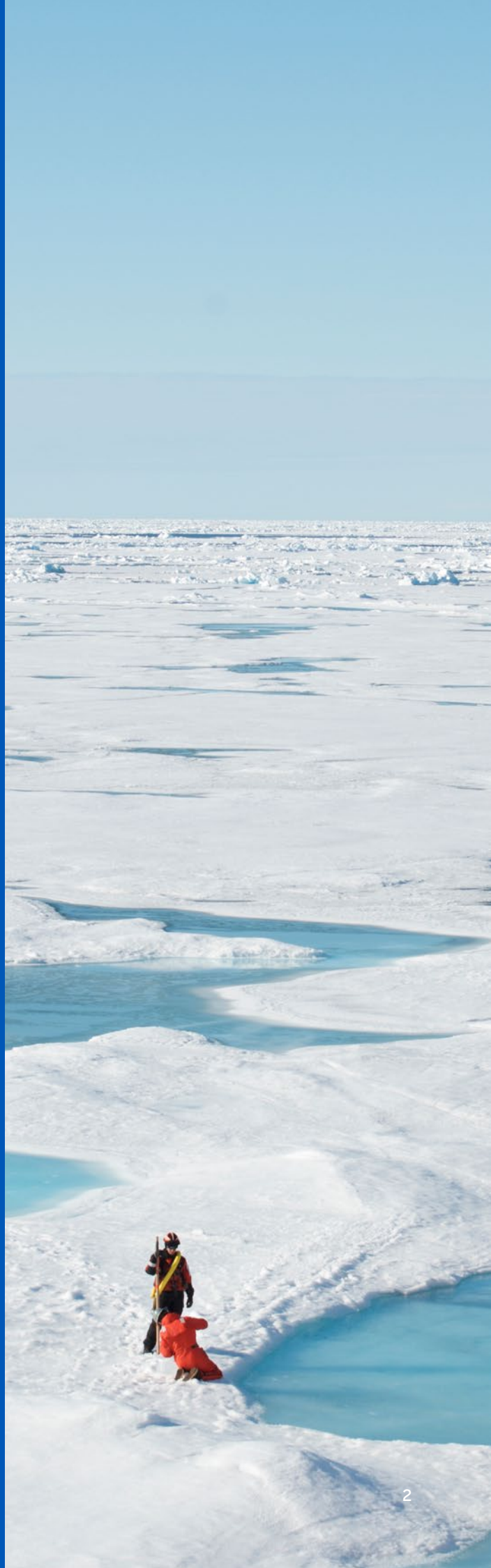
Eva Cairns
Head of Sustainability Insights & Climate Strategy

Alexandre Popa
Sustainability Analyst

Jeremy Lawson
(Former) Chief Economist and Head of the abrdn Research Institute

David Attwood
Senior Investment Analyst

Nick Gaskell
Sustainability Analyst

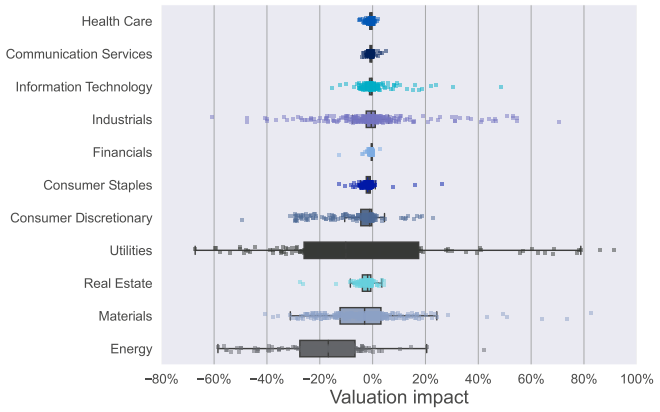


Key Takeaways

- **Climate scenario analysis is a critical activity for investors to understand and quantify the longer term risks and opportunities associated with climate change.** We have updated our analysis to incorporate durable signals from changes to the underlying drivers and developments embedded in our scenario design. This paper provides an overview of the implications for investments and a comparison to our last update.
- **Four major forces experienced in 2022 have shaped our Year 3 scenario updates:** The war in Ukraine and derailing of climate action as energy security and affordability took priority; the upward revision of economic growth forecasts; and the changes in patterns of energy use due to the relative cost of renewables falling more than expected.
- **We have continued to enhance our innovative approach to bespoke scenario design by:** incorporating more realistic blended scenarios and a new scenario; updating our Baseline and probabilities; improving the methodology used to estimate the probability of default for fixed income investments; and exploring metrics that provide more detail on the timing of impacts.
- **The changes alter the expected scale, speed and composition of the energy transition.** Increased policy ambition and cheaper low-carbon technology result in greater decarbonisation and lower costs. However, we expect higher energy demand overall and materially higher gas demand in developing countries.
- **As a result of these changes, the temperature outcome of our mean scenario is now higher at 2.3°C vs 2.2°C in Year 2, showing we are falling behind on achieving Paris goals.** This is an important consideration for investors with net zero ambition as the world is not on a trajectory to achieving these goals. There is a misalignment as policies do not support investing at the pace and scale required to achieve net zero by 2050.
- **Across regions and sectors, we maintain the same ordering of decarbonisation**, but there have been changes to the speed and completeness of the transition in different regions and sectors.
- **When it comes to the financial impact on equity and fixed income valuations**, as before, these are modest at the aggregate level as leaders and laggards offset each other within an index. Energy still shows the greatest sector-level impairment, with Utilities having the only significant uplift.
- **Our key takeaway remains: actionable insight comes from looking at the dispersion across and within sectors.** Therefore, at the individual asset level the financial impacts can be material.

Estimated impairments are highly dispersed within sectors

%



Source: abrdn, February 2023. Probability weighted mean scenario

- **Importantly, our Year 3 analysis also includes the assessment of firms' corporate targets and their credibility.** We show that taking account of credibility-adjusted targets can have a considerable impact on valuation uplifts and impairments, particularly for Utility companies.

Like any modelling exercise, ours is an approximation and a simplification of the complexities of the real world and so, while it provides useful insight, it has its limitations. While we believe our financial exposure estimates are more robust than standard off-the-shelf or reference scenarios, the results should always be complemented by fundamental analysis before any financial decisions are made.

Our bespoke approach to climate scenario analysis

Climate change is one of the defining issues of our age. Its physical manifestations are negatively affecting ecosystems, human health, and economic infrastructure. And even if the world is able to keep global temperature increases to 1.5°C above pre-industrial levels, much more disruptive outcomes are coming. Meanwhile, energy systems and patterns of economic activity are being profoundly changed by the growing array of policy initiatives, private-sector commitments and technology advances that aim to constrain greenhouse-gas emissions and limit climate change.

It is vital that investors understand how physical climate change and the energy transition affect the investment returns of the companies and markets in which they invest. We believe that doing so will enable us to build more resilient portfolios, encourage positive change at the companies in which we invest, and generate better long-term returns for clients. However, there is still uncertainty regarding exactly how policies, technologies and physical impacts will unfold in the future.

Climate scenario analysis provides the means to conduct forward-looking, quantitative assessment of the potential financial impacts. However, the typical 'off-the-shelf scenarios' approach provides a very rigid assessment, often based on an assumption of uniform policy and inflexible technology pathways across geographies and sectors. These unrealistic assumptions will generate misleading results across the universe of securities and indices in which we and our clients invest. We have taken a market-leading, proprietary approach to developing climate scenarios that allows us to bring our own research-driven political, policy and technology insights into the analysis.

In February 2021 we published the findings from the **first year (2020) of our climate scenario analysis**. As part of our approach, we aim to update this analysis annually to account for significant changes in the drivers of long-term climate risk and innovation, to improve the rigour of our methodology- and thereby, maximise the insight this can bring to investment decision-making. Our **second year (2021) of analysis** reflected the evolution of investment risk and opportunity since the Covid crisis. This paper provides an overview of our third-year (2022) update, and should be read in conjunction with earlier papers.

Our approach to climate scenario analysis continues to be based on the core beliefs that:

1. The political economy and economics of climate change mitigation vary across geographies and sectors.
2. Climate-related policy and low-carbon technology pathways are difficult to forecast over long horizons. Accordingly, there are a wide variety of plausible ways in which energy-usage patterns might evolve.
3. Given the two prior statements, any approach that assumes uniformity of policy across geographies and sectors or is based on a single fixed view of future technological change, will generate misleading results.

We have collaborated with our modelling partner Planetrics to develop and update our analysis. We continue to improve on the insight available through typical approaches, and thereby better enable the integration of climate scenarios into our investment decisions and climate solutions for clients by:

1. Reflecting critical regional and sectoral characteristics.
2. Assigning probabilities to our scenarios, allowing a much larger proportion of the probability distribution to be considered, and using these to create a 'mean', or most likely, scenario.
3. Including a baseline reflecting what's currently priced into the market.
4. Considering the impact of company transition strategies.
5. Communicating financial impacts via our internal asset and fund-level tools.

Updating our climate scenarios

What's new in Year 3?

We have updated our range of off-the shelf and bespoke scenarios (16 in total including our Baseline reflecting what is currently priced in) and the probabilities that we assign to them, as illustrated in Figure 1. As in previous years, the probabilities we assign to the suite of scenarios are used to create two further probability-weighted scenarios: our Probability-weighted mean scenario (based on the full suite) which reflects our view on the most likely path we are currently on and our Paris-aligned mean scenario (based on the weights assigned to the eight scenarios with a 2100 global temperature rise below 2°C). Table A1 in the Appendix provides further detail on individual scenarios.

"Our Year 3 analysis suggests that we are falling behind on achieving Paris goals as the temperature outcome of our mean scenario is higher at 2.3°C vs 2.2°C in Year 2. Understanding associated risks and opportunities is critical for investors with net zero goals."

Anna Moss
Senior Sustainability Analyst

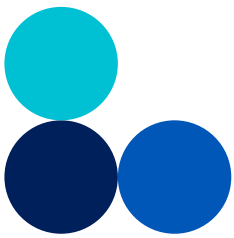
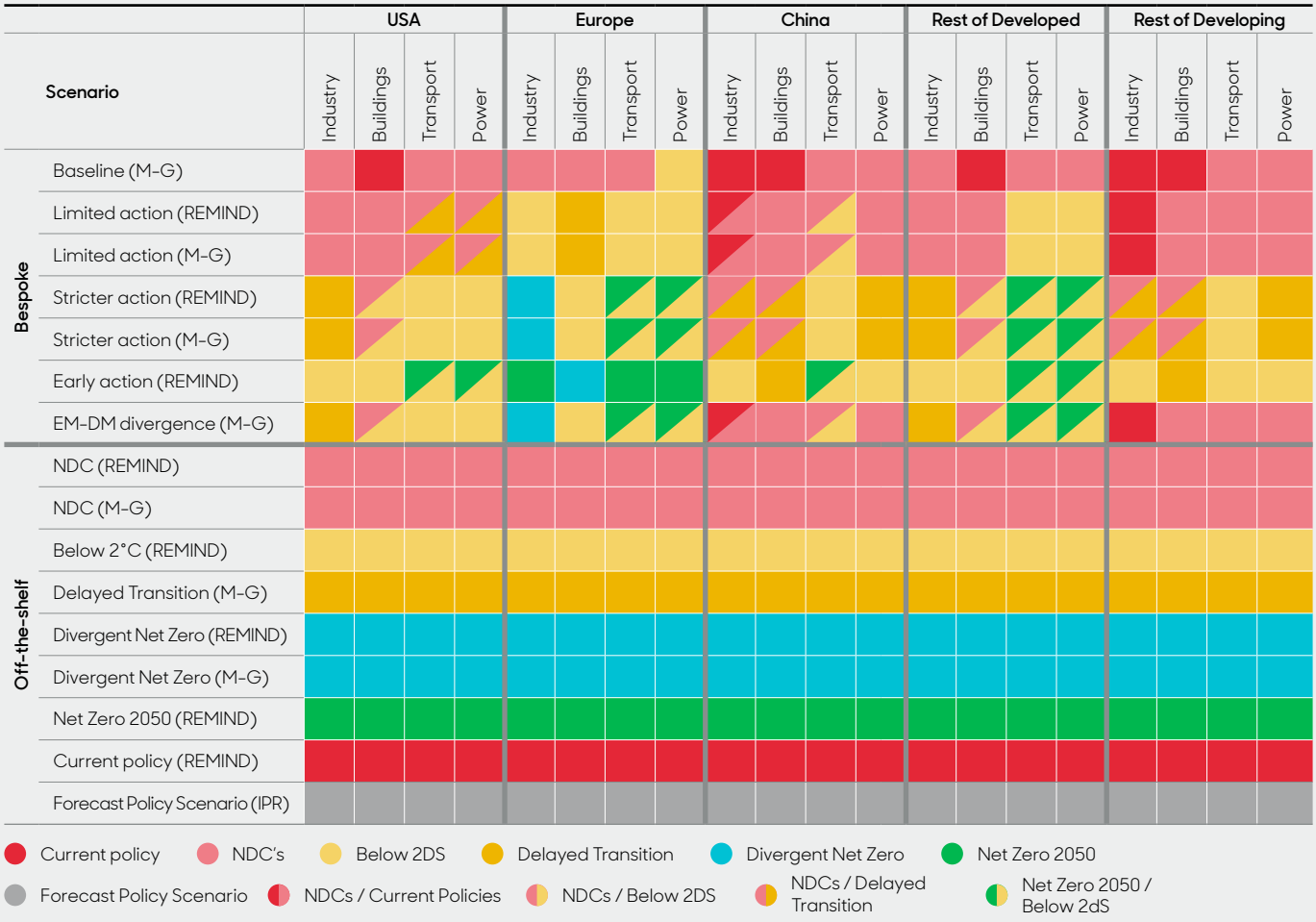


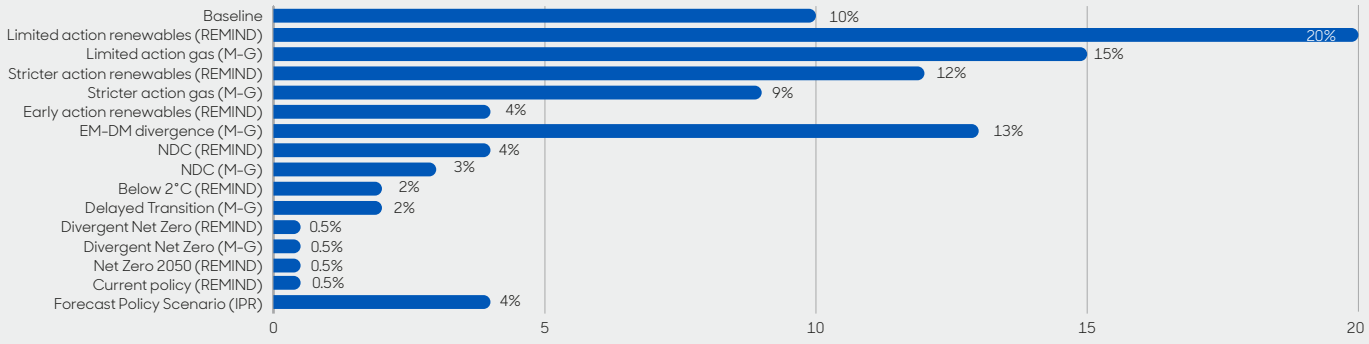
Figure 1: Year 3 scenarios and probabilities



Source: abrdn, September 2022. Our scenarios utilise 2 underlying energy systems models- REMIND-MAgPIE 2.1-4.2 (REMIND) and Message-Globiom (MG). Abbreviations: NDC- Nationally Determined Contributions; IPR- Inevitable Policy Response; 2DS- 2°C

Probability

Scenario weightings (%)



Source: abrdn, September 2022.

The drivers of long-term climate risks continue to evolve

Each year we update our bespoke **climate scenarios** to incorporate the durable signals from any changes to the underlying drivers of long-term transition and physical climate risk. This year's update was shaped by four major forces:

1. **The war in Ukraine and the economic, political and policy changes it has unleashed.**

   The war significantly increased the relative cost of energy derived from fossil fuels. It forced Europe to reduce its dependence on Russian oil and gas imports, while increasing the dependence of major emerging countries like China and India. And more generally it has led governments to recast their energy and climate policies with a greater focus on energy security and affordability (**Further detail on the impact on the energy transition**).

2. **The stalling of upgrades to credible global decarbonisation commitments.**

   The latest **Network for Greening of the Financial System (NGFS)** scenarios we draw on in our analysis, now incorporate all the pledges made at, in the run-up to and immediately following COP 26 in Glasgow at the end of 2021. Since then, however, and despite the promises made in Glasgow, only 24, largely small economies, upgraded their Nationally Determined Contributions (NDCs) ahead of **COP27** in Egypt. As a result, **Climate Action Tracker's assessment** is that the world is still on track to significantly overshoot 2°C of warming by the end of the century. Though the past year did see some significant legislative breakthroughs like the US Inflation Reduction Act (IRA), these largely fell short of what is required for Paris alignment and were already factored into our forward-looking policy projections.

3. **Revisions to long-term economic growth projections.**

   Last year's update occurred at a time when the IMF had become especially pessimistic about the long-term global economic outlook in the immediate wake of the pandemic. The subsequent faster-than-forecast recovery in growth has since been incorporated into the NGFS scenarios which has in turn lifted the assumed long-term size and geographic composition of the global energy market.

4. **Secular changes in patterns of energy usage and investment**.

   The relative cost of renewable energy technologies has declined more than expected. Renewable penetration and investment rates increased faster, since our last update, even when controlling for the effects of the Ukraine war. Assessments of future technological change have also become more optimistic and are incorporated into NGFS scenario assumptions. These changes have also lowered carbon prices in the most ambitious scenarios, reducing the costs associated with more aggressive decarbonisation.

Embedding innovation into our scenario design

We have also introduced a number of innovations that further enhance the investment applicability of our bespoke approach:

1. **Blended scenarios- aligning policy to even more realistic pathways**. Even the least ambitious NGFS transition scenario – 'Below 2°C' – results in average global temperature increases being limited to 1.6°C above pre-industrial levels by 2100. Meanwhile the NGFS scenario predicated on countries doing no more than implied by their NDCs, is aligned with 2.6°C of warming. That means that when making region/sector choices in our previous exercises, we were often limited to choices that differed by 1°C in their temperature alignment. By using NDC/Delayed Transition (and other) blends, we have been able to significantly narrow these policy gaps, further filling in the probability distribution and generating carbon cost pathways that are closer to what can be realistically expected. The use of blended scenarios in our latest scenarios is illustrated by the use of dual-coloured boxes in Figure 1.
2. **Inevitable Policy Response (IPR) scenario- we have added the IPR Forecast Policy Response to our 'off-the-shelf' suite**. This relaxes some of the economically optimal decarbonisation pathways found in the NGFS scenarios and integrates the 2025 Paris Agreement Ratchet as a tipping-point which accelerates policy stringency. For example, this IPR scenario has a faster acceleration of electric vehicle (EV) sales over the next decade than any of the other scenarios in our suite, with associated acceleration in demand for materials needed to drive this transition. The new IPR scenario now appears at the bottom of our scenario chart and is assigned a probability weight of 4% (Figure 1).
3. **Fixed income methodology- we have refined the methodology for estimating default probabilities for corporate bonds**. We now have a better way of estimating the probability of default for companies close to the threshold of default. The model for calculating Altman Z scores has been improved. And we make use of synthetic Yields to Maturity that exclude credit risk. Expected payments associated with each corporate bond are calculated based on the survival probability and loss given default for each issuer in each period, under each scenario. Expected payments are then discounted back to present value terms to calculate the bond price. The resulting bond price estimates under a climate scenario and the baseline scenario are then used to calculate the percentage change in the valuation of each bond under that climate scenario. This enables us to consider the impact on both equity and fixed income utilising the same metrics of value impact. (see Appendix for more detail).
4. **Company transition targets and credibility assessment- we have expanded the number of equity and fixed income securities included in this aspect of the analysis.** Last year we were able to include companies' transition plans in an additional modelling exercise for the first time, but for fewer than 400 firms. This year we have increased this to around 1,200 companies, covering almost 2,000 equity securities and over 20,000 corporate bonds. 79% of the 1000 largest market capitalisation companies in the MSCI ACWI are now covered. This expansion in scope also applies to firms covered by our credibility assessment framework.
5. **Updated firm-level financial information**. The latest modelling (Sept 2022) now incorporates more recent information on equity and fixed income sector and sub-sector weights, refreshed data for companies' market implied growth rates, financial position and business structures, as well as their carbon emissions profiles. Our climate scenario analysis covers over 22,000 equity and 55,000 fixed income assets, but within this paper the majority of the analysis is based on companies in the MSCI ACWI Index.
6. **Explored additional temporal metrics**. Our analysis now provides us with temporal variables which are providing us with additional insight into when financial impacts will be most material for a company over the next 30 years. Table A2 in the Appendix provides a summary of additional metrics.
7. **Asset class scope- we have broadened our bespoke climate scenario platform to include listed real estate assets.** This aspect is not covered within this paper, but we will be sharing the details of our approach to real assets and the results of that exercise in a follow-up note.

Implications of these changes for our scenario framework

All of this information has been combined to generate the key changes to our scenarios (Figure 1) as outlined below:

1. **Faster decarbonisation in the Baseline**. The region/sector assumptions for our Baseline scenario are unchanged from our previous exercise. This is underpinned by our analysis suggesting that only in the European power sector is the market pricing in a faster transition than implied by NDCs or Current Policy. However, because of the upgrades to policy ambition within the NDCs, and more optimistic projections for low-carbon technology costs, the Baseline is now associated with faster decarbonisation. The financial implications of our scenarios are calculated relative to our Baseline. We therefore ensure that the annual review and revision of the Baseline draws on regional and sectoral expertise across the company. This provides us with the best estimate for what level of policy and action is being priced into the market at a broad sector and region level at the time of modelling.
2. **We maintain the same ordering of decarbonisation across regions and across sectors**. The developed economies (DMs) achieve more decarbonisation than the developing/emerging economies (EMs). Within the DMs, Europe achieves the most decarbonisation, the US the least, and the rest of the DMs (rDMs) are in the middle. Within the EMs, we consider China to be on a faster transition pathway than the average across the rest of the EM (rEM) economies. And then, given technology maturity and the focus of climate policy and regulations, the Power and Transportation sectors achieve greater decarbonisation than the Industry and Buildings sectors.
3. **But there have been changes to the likely speed and completeness of the transition for some region/sector choices across the bespoke scenarios**. The most important of these are shown in the table below.
4. **Greater warming in our weighted mean scenarios**. The probabilities assigned to the individual bespoke and off-the-shelf scenarios are little changed. Consequently, the probability we attach to global climate policies aligning with the objectives of the Paris Agreement is also more or less unchanged at 34.5%. However, the temperature alignment associated with our probability-weighted mean (2.3°C) and Paris-aligned[1] mean scenarios (1.9°C) has increased. This is because we are making greater use of blended scenarios that most often imply less decarbonisation than in our previous update. In short we are not currently on a Paris aligned trajectory and our analysis suggests that the most likely outcome is a 2.3°C world. This is important to consider for investors who want to align their investments with a net zero 2050 pathway but operate within a misaligned policy landscape. Even if the world were to align with the objectives of the Paris Agreement, our research suggests that temperature rises are most likely to reach the upper end of the target range.

Region	Sector updates
US	• Timing of policy action in the Power and Transport sectors in the Limited Action scenarios brought forward in response to the passage of the IRA. • However, the Early Action scenario is now a little less ambitious as we think a blended Net Zero 2050 and Below 2°C scenario is more realistic.
Europe	• That same approach to the probability of Net Zero alignment by 2050 in the Power and Transport sectors also carries over to Europe, where we have modestly downgraded ambition to a blend in the Early Action and EM-DM divergence scenarios.
China	• We are now factoring in additional policy progress. • Our use of blends has allowed us to bring forward action in Industry and Buildings in the Early Action scenarios. • However, we now have less action in the Transport sector as NDC/Below 2°C blends were deemed more appropriate than the Delayed Transition.
Rest of Developed	• Here we have seen perhaps the greatest and most credible changes to ambition and policy. • Greater policy ambition and improved decarbonisation targets in both Australia and Japan, for example. • As a result, we have either brought forward the timing of policy changes in the Power and Transport sectors (Limited Action) or upgraded ambition (Stricter Action and EM-DM divergence).
Rest of Developing (Emerging)	• Here there have been the fewest changes. • Though policy directed towards the Buildings and Transport sectors is now modestly more ambitious in the Stricter Action scenarios to reflect those countries roles as 'technology takers'.

[1] The Paris-aligned mean scenario is based on the weights assigned to the scenarios which are projected to result in less than 2°C of global warming by 2100.

Implications for the energy transition

The outlined scenario changes alter the expected scale, speed and composition of the energy transition. Because all our projected changes in value are calculated relative to our Baseline, any changes in our Baseline drivers (such as carbon price, energy demand etc) will result in relative changes to the output of our other scenarios. Table 1 provides a summary comparison of some of the key scenario metrics and how these have changed between our Year 2 and 3 exercises.

Table 1: Projected energy demand, renewable energy share, and carbon price under different scenarios (Year 2 in brackets)

Category	Measure	Probability-weighted mean	Baseline	Paris-aligned mean	Current policy
Temperature change	2100, compared to pre-industrial levels	2.3°C (2.2°C)	2.7°C (2.8°C)	1.8°C (1.6°C)	3.2°C (3.1°C)
Share of non-fossil power generation	Share in 2050	82% (78%)	59% (59%)	97% (93%)	79% (64%)
Coal demand	Annual growth 2020-2050	-2.65% (-3.13%)	-1.95% (-1.98%)	-5.85% (-9.65%)	0.82% (0.50%)
Gas demand	Annual growth 2020-2050	0.52% (-0.16%)	1.98% (1.47%)	-1.43% (-2.34%)	0.77% (0.19%)
Oil demand	Annual growth 2020-2050	-0.97% (-0.86%)	-0.08% (0.18%)	-2.03% (-2.07%)	-0.98% (-0.08%)
Electricity demand	Annual growth 2020-2050	2.66% (2.30%)	2.38% (2.04%)	3.00% (2.56%)	2.44% (1.99%)
EV sales	EV share of new vehicle sales in 2050	86% (90%)	80% (74%)	96% (99%)	73% (58%)
Carbon price	$/tCO$_2$ in 2050	316 (352)	49 (64)	656 (685)	7 (64)

Source: abrdn, October 2022.

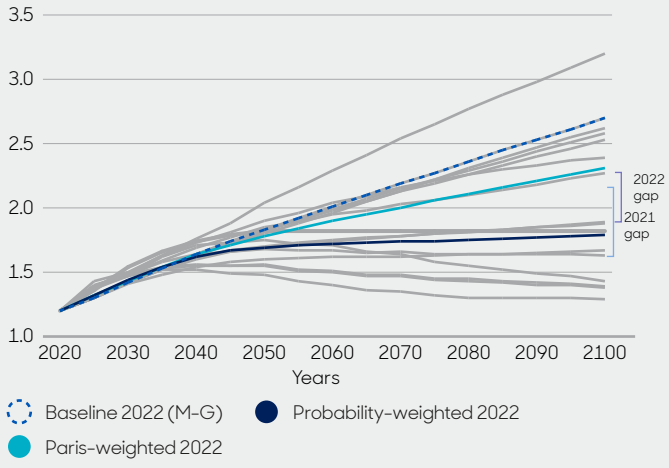
1. Temperature: Slower decarbonisation pace leads to greater warming

We have lowered the decarbonisation pace we expect to see by 2050 (utilising blended scenarios), which results in greater warming in the later part of the century. As a result, our mean scenario now has a rise of 2.3°C, this is 0.1°C higher than our 2021 exercise. Whilst we believe this reflects the currently most likely outcome, our Baseline has a slightly lower global temperature rise than its 2021 equivalent (2.7°C vs 2.8°C) as a result of the publication of more ambitious NDCs and the availability of cheaper decarbonisation options which we believe are already being priced in to the market.

In our 2021 exercise we found that our scenarios had quite a sizeable divergence gap in temperatures by 2100 of approximately 0.7°C centring on 2°C (1.7°C to 2.4°C) (excluding the mean scenario). This year, due in large part to the use of blended scenarios, we have almost halved that gap in our temperature profiles (see Figure 2), allowing us to provide greater coverage of that important, and more probable, middle-ground.

Figure 2: Projected scenario temperature pathways to 2100

Temperature rise relative to pre-industrial levels



Source: abrdn, November 2022. Full suite of scenarios shown. The divergence gap refers to the temperature range not covered in our un-weighted scenarios. The range is significantly lower than in the off-the-shelf approach.

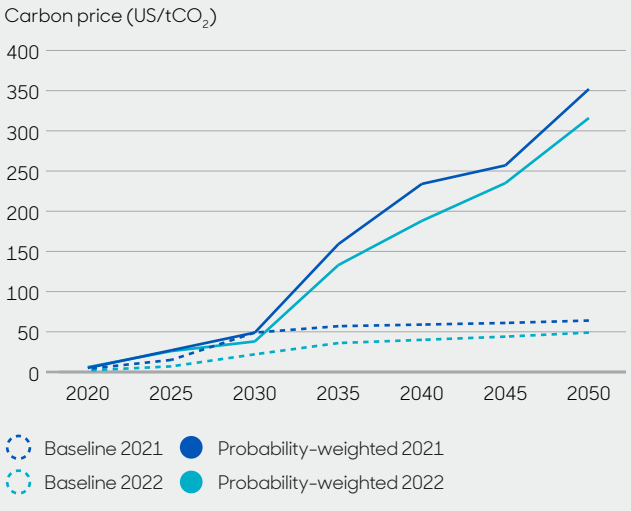
2. Carbon costs: Increased policy ambition and cheaper low-carbon technology result in impact on projected future carbon costs

Explicit (or implicit) carbon prices across all sectors and geographies, will need to rise steeply over time to help drive global decarbonisation. However, our latest scenarios show a revision to that projected rise.

Whilst the policy profile for the Baseline remains the same as our 2021 exercise (see Figure 1), the increased ambition of NDCs and reduced low-carbon technology costs result in greater decarbonisation in our Baseline than our 2021 exercise. This is then reflected in lower projected carbon prices compared to 2021, and consequent lower direct carbon costs at asset level.

Whilst the gap after 2030 between the carbon price profile for our Baseline and our mean scenario remains large (indicating an underestimation by financial markets), the gap has slightly diminished in comparison to our 2021 analysis (Figure 3). The lower delta between Baseline and the mean (reflecting the use of the bespoke delayed scenario blends) results in lower average direct carbon costs for assets after 2035 than in last year's analysis.

Figure 3: Lower carbon prices in our latest update



Source: abrdn, November 2022.

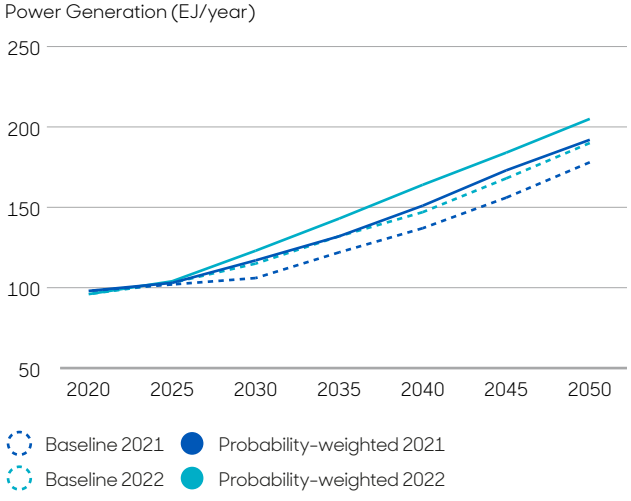
3. Energy demand: Less pessimistic long-term economic growth projection increases overall demand

Last year, post-Covid downward revisions to cumulative economic growth shifted the entire profile of oil consumption down and reduced the scale of the future electricity demand increase in the 2021 exercise compared to 2020. More recent forecasts have revised GDP up and therefore increased overall energy demand in our 2022 exercise.

Our 2021 exercise saw an increase in the global share of non-fossil fuel power sector generation in our mean scenario. The continued combination of greater policy ambition and more optimistic assumptions about the relative cost of renewable technologies now means that this is projected to increase to 82% by 2050, 4 percentage points higher than last year's analysis. Even if global policy does not align behind the objectives of the Paris Agreement, the power sector is likely to be the epicentre of a significant energy transition.

This year's analysis shows an increased demand for electricity in the Baseline and is also reflected in our mean scenario (Figure 4). This is due to higher economic activity and a reduction in costs for low-carbon technology. This is manifested immediately in the Baseline and therefore we see less near-term demand creation as a result in this year's exercise compared to last year.

Figure 4: Increased energy demand in the Baseline and the mean scenario

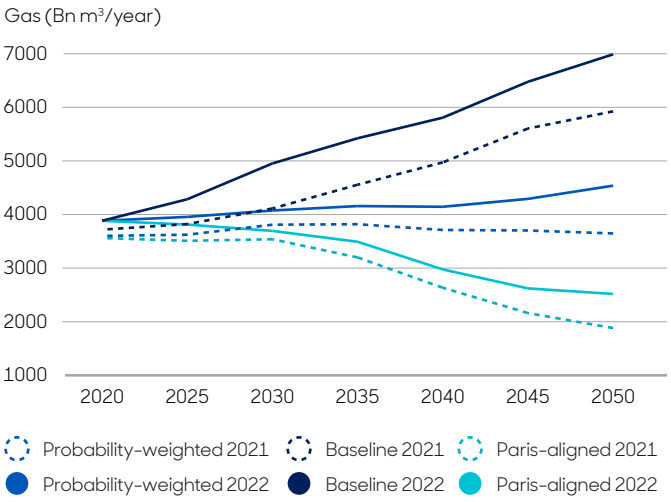


Source: abrdn, November 2022.

4. Fossil-fuels: Near-term demand increase expected, particularly for gas

Whilst there are only very marginal changes in oil demand, both gas and coal see some significant shifts in our latest analysis. Materially higher gas demand in developing countries drives an overall increase in gas demand. The increase in the Baseline's policy ambition places gas in something of a 'sweet spot' as policy favours gas against coal and consumers stop short of switching from gas to renewables. Whilst our mean scenario also sees an increase in gas demand, a greater delta between the Baseline and the mean scenario results in more demand destruction to 2045 (see Figure 5).

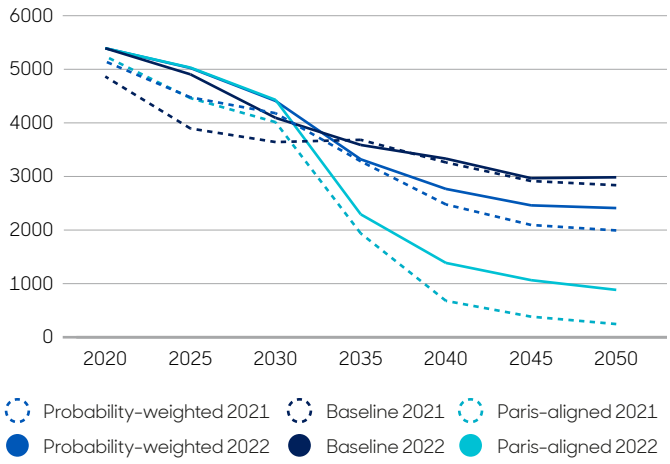
Figure 5: Higher gas demand in developing countries drives an overall increase in global gas demand



Source: abrdn, November 2022.

We project coal usage to decline by 55% in our mean scenario from today's levels, versus 45% in the Baseline, and to be almost removed in Paris-aligned pathways (Figure 6). However, short-term demand for coal is modestly higher in our 2022 Baseline due to higher economic growth, with higher long-term demand due to a greater likelihood of delayed action across our scenario suite (Figure 1).

Figure 6: Higher short-term demand for coal



Source: abrdn, November 2022.

Financial impacts on equity and fixed income: what has changed?

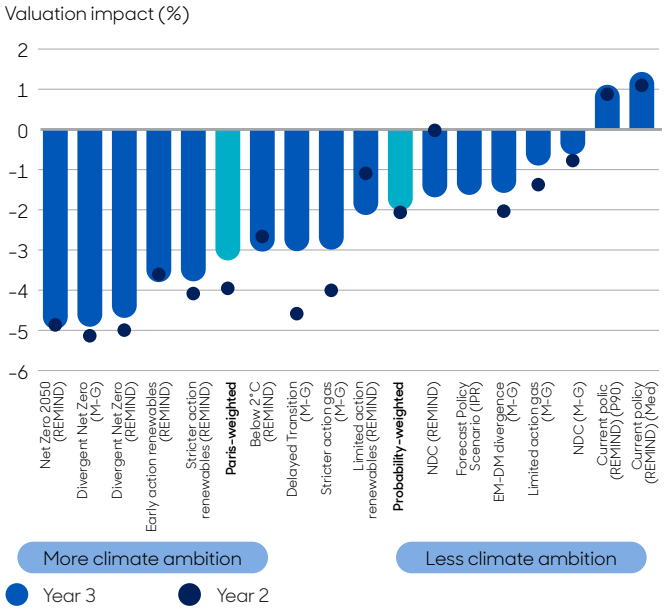
The manner in which our scenario updates alter the expected scale, speed and composition of the energy transition determine the estimated financial impacts on securities. The impacts in our analysis can be broken down into seven value impact channels- physical impact, adaptation, demand destruction, demand creation, direct carbon costs, abatement and cost pass through.[2] The changes outlined above particularly alter the outlook for demand dynamics and carbon costs. This leads to changes in impairment and uplift estimates for listed equity and credit valuations (and probability of default), especially in sectors most exposed to transition risk.

Aggregate portfolio and sector level

Equity

At the aggregate scenario level our equity results (MSCI ACWI) are similar to our second year exercise and are generally modest (Figure 7). The valuation impairment in the Probability weighted mean scenario stands at -2.0% (versus -2.1% in 2021). Most scenario impairments are relatively unchanged, though cheaper decarbonisation, and less stringent stricter action scenarios does result in reduced impairment in the Paris-weighted scenario (-3.3% in 2022 compared to -4.0% in 2021). As before, on the whole, the greater the policy ambition that is incorporated into a scenario the greater the resulting aggregate value impairment. This weighted aggregate scenario is also impacted by the inclusion of the IPR scenario this year, which has the lowest carbon pricing and lowest level of non-fossil fuel power generation of all our Paris-aligned scenarios.

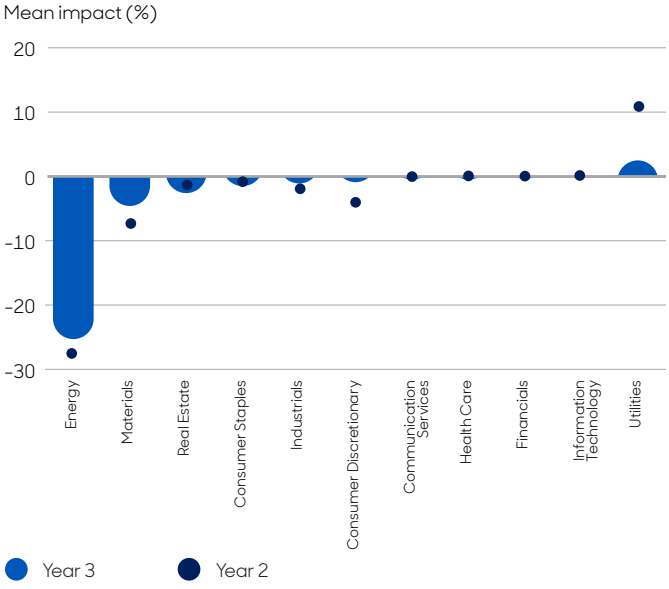
Figure 7: Global equity valuations 2021 (Y2) and 2022 (Y3)



Source: abrdn, February 2023. MSCI ACWI index weighted by market capitalisation. Weighted scenarios highlighted.

At the sector level (Figure 8), Energy is still the most impaired sector due to significant demand destruction, and hefty carbon costs which cannot be sufficiently abated or passed through. As in Year 2, Utilities is the only sector that shows opportunities at the aggregate level. Although the sector is subject to the highest carbon costs, firms are able to pass the majority of those costs through. Utilities also benefits from the highest sector demand creation, due to increasing demands for electricity (with demand creation being highest for energy from renewable sources).

Figure 8: Equity valuation impacts by sector (Probability-weighted mean scenario)



Source: abrdn, February 2023. MSCI ACWI Index weighted by market capitalisation.

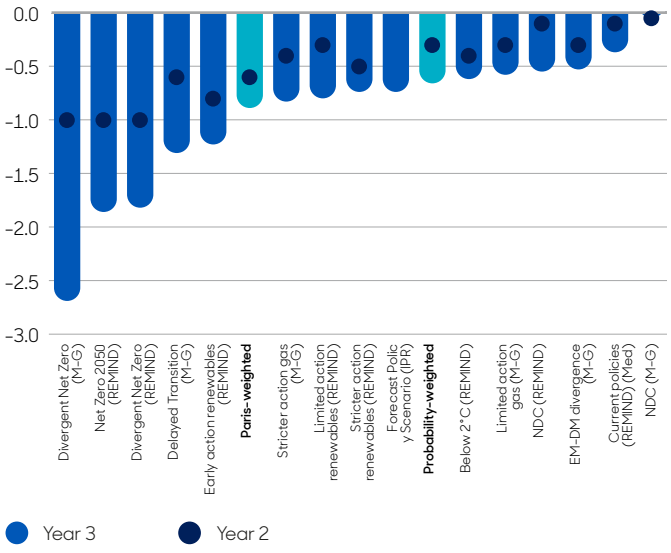
[2] See **here** for further detail.

Fixed Income

Although Fixed income impairments are more modest than for Equity, climate impact becomes considerably more material in our latest update. The mean valuation impairment[3] has more than doubled from -0.3% in 2021 to -0.7% in 2022 in our Probability-weighted mean scenario (Figure 9). This change in large part stems from the methodological enhancements which increased the sensitivity of outlying companies and those projected to be near default (see Appendix for details). However there are no significant changes in the relative order of impact seen across the scenario suite.

Figure 9: Global Fixed Income valuation

Valuation impact (%)

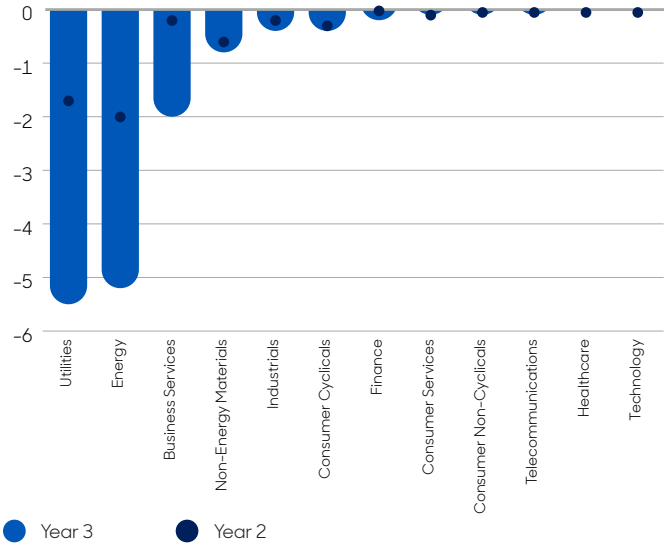


Source: abrdn, February 2023. Bloomberg Aggregate Index Corporate weighted by market value.

Impacts are more material at the sector level (Figure 10) in comparison to our Year 2 analysis. The valuation impact declined from -1.7% to -5.5% for Utilities, and from -2% to -5.2% for Energy in the mean scenario. The most severe risks are found for these two sectors. While various Utilities equities show large positive impairments (Figure 8), risks matter more than opportunities for fixed income given the nature of the financial instrument and how investors tend to assess their intrinsic values. As outlined in our **second year paper** there is cap on the valuation uplifts as implied default rates cannot fall below 0. As mentioned above, these changes need to be considered in light of the methodological enhancements (see Appendix).

Figure 10: Fixed income valuation impacts by sector (Probability-weighted mean scenario)

Mean impact (%)



Source: abrdn, February 2023. Bloomberg Aggregate Index Corporate weighted by market value.

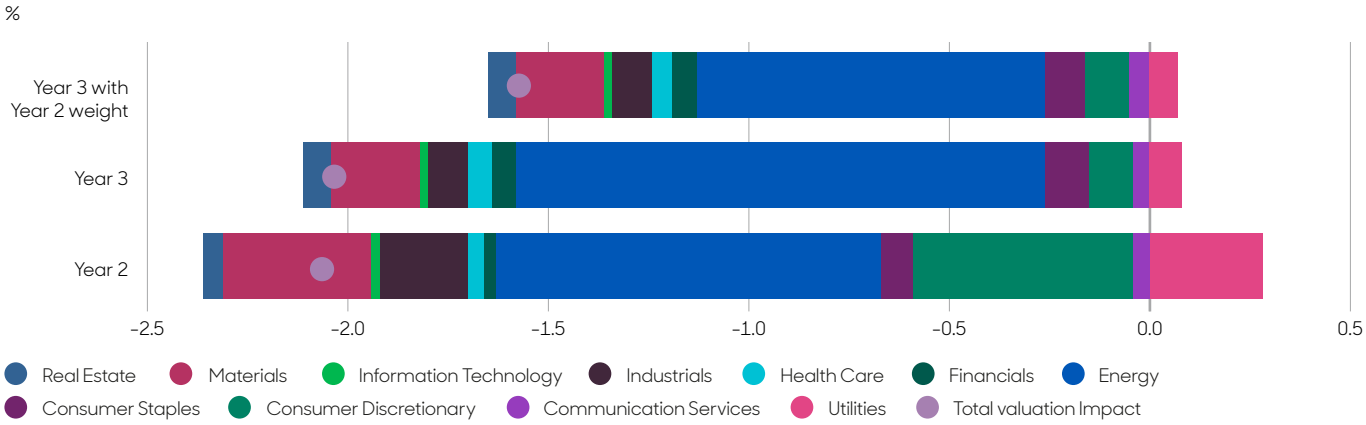
[3] Standard bond value techniques are used to translate changes in default probabilities into changes in bond value- see Appendix for more detail.

The importance of sector weights

Changes in sector weights shape the aggregate valuation impairment

We have outlined previously how dependent aggregate results are on the sectoral exposures of an investment or position. It is therefore important to not only look at the individual sectoral results, but also to understand their weights in global indices. The share of the Energy sector in the MSCI ACWI Index increased from 3.5% to 5.2% between our 2021 and 2022 exercise as energy valuations rose given soaring energy prices resulting from the Russian invasion of Ukraine, and continued supply chain issues. The increased Energy weight more than offset the improved valuation impairment. Had the weights been unchanged, the negative valuation impairment in the index would have been lower, at -1.6%, compared to -2.0% (Figure 11). Consumer Discretionary, which includes Automobile companies, has seen a reduced index-level impact when compared to 2021 where it was the second largest contributor- we discuss this in more detail later in the report. We also observe smaller contributions from both Materials and Utilities. Figure 11 also illustrates that the bulk of the risk remains in the Energy sector.

Figure 11: Changing sector weights shape aggregate valuation impacts



Source: abrdn, February 2023. MSCI ACWI index weighted by market capitalisation. Sector contributions to Index level.

"Our key takeaway remains: actionable insight comes from looking at the dispersion across and within sectors"

The implications for public market expected returns

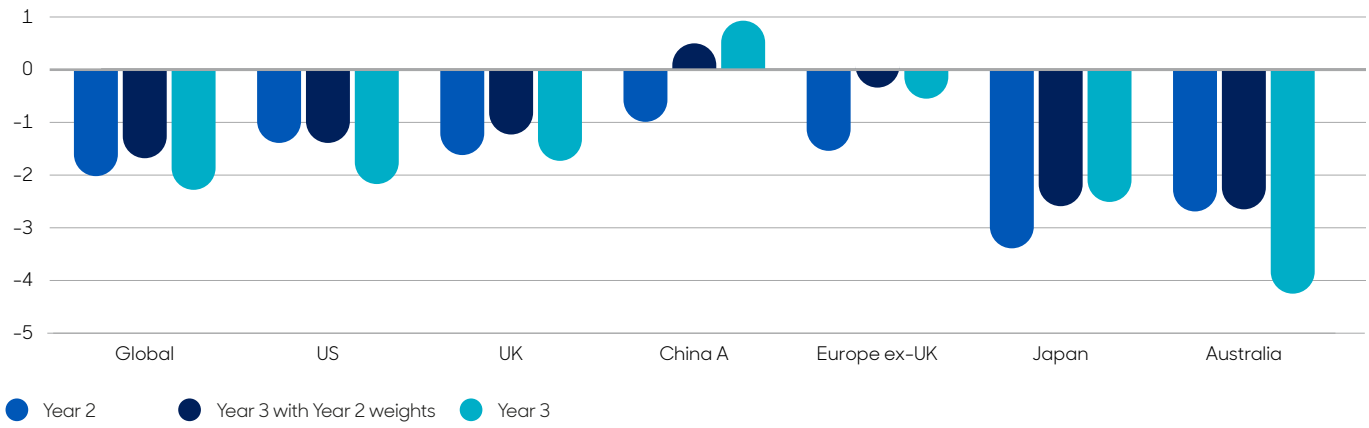
Questions are often asked about key equity benchmarks, and their associated aggregate impairment. Figure 12 shows the application of this analysis of sector weights (for our Probability-weighted mean scenario) to a set of core equity benchmarks relevant to most global investors.

The results show that index-level results are small, especially given the 30-year modelling horizon. However, as discussed above, the sectoral make-up of indices is vital in explaining the aggregate results:

- **US**: In our Year 2 analysis the US Technology sector made up c. 40% of the index. However, this is a sector that has minimal exposure to the climate transition, and hence contributed little to the slightly negative index-level impairment. Turning to our Year 3 data, the Technology sector weight has declined to c.33% as the outlook for these business models declined amidst regulatory headwinds, declining advertising revenues, and the general deterioration of macro-economic condition, leaving room for more energy-intensive and climate-exposed sectors to grow in the index. This explains the majority of the increased negative impairment we see for US equities.
- **UK and Australia**: The UK and Australia saw significant increased weights to the Energy companies given elevated energy prices and associated increased profitability in the latter part of 2022, therefore increasing the index-aggregate negative impairment.
- **China**: The one notable exception to this sectoral rebalance is China's aggregate impairment turning positive, reflecting more optimistic Utilities and Industrials sectors due to more ambitious policy (these sectors make up c. 20% of the index).
- **Company impact on indices**: Individual names with large index-weights can often move the dial, for example Toyota in the Japan equity index, which saw material upgrades in its outlook given our updated baseline view reflects more electric-vehicle optimism.

Figure 12: The combined impact of regional index composition and modelling refresh

Valuation impairment (%)



Source: abrdn, February 2023. Probability weighted mean scenario.

Financial impacts through a sector lens

Dispersion is still key

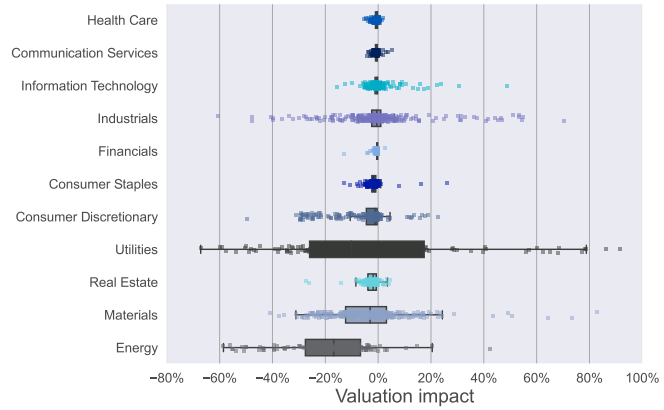
Our Year 3 climate scenario analysis reiterates one of our main takeaways: climate scenario analysis is mostly a micro phenomenon. As Figures 7 and 9 above show, the impairment and uplift differences between scenarios is relatively small, even between the tail scenarios. This is because at that aggregate level the negative effects on many individual securities are mostly offset by positive effects on others. Even at aggregate sector level the differentiation is relatively minor. However, when you consider the dispersion within each sector it affirms our original conclusions that climate risk and opportunity is mostly a micro, or security level, phenomenon. That is because there is much greater dispersion across securities within a sector or a region, than there is across the sectors or aggregate regional indices themselves (Figure 13).

We obtain further insights when we consider dispersion of impacts at the sub-sector level. Industrials is marginally impacted at -1.1% in the mean scenario, however this hides significant variation at sub-sector level (Figure 14). Most Airlines and Marine companies are heavily impaired from large carbon costs that are difficult to abate. On the other hand, many Electrical or Construction & Engineering corporates benefit from increased demand for green infrastructure.

We will now focus on a number of key sectors that are most impacted and/or dispersed (Utilities, Energy, and the Auto sub-sector) - identifying the main drivers for uplift or impairment, key changes resulting from our year 3 update, and providing examples of additional insight that can be drawn from the analysis.

Figure 13: Estimated impairments are highly dispersed within sectors

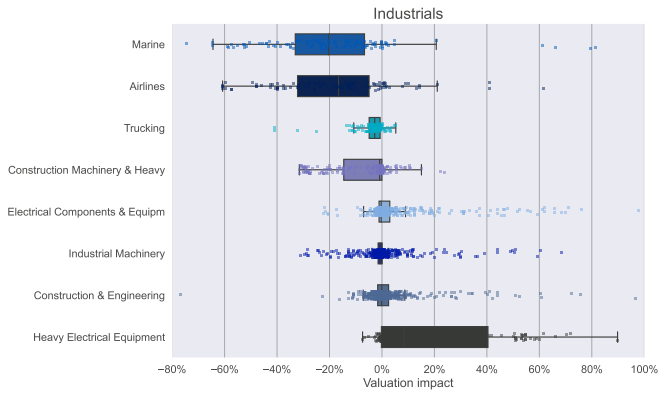
%



Source: abrdn, February 2023. MSCI ACWI Index. Probability-weighted mean scenario. Stocks with a valuation uplift above 100% are not displayed. The box plots identify the interquartile range between the 25th and 75th percentile value of the data. The horizontal bars identify the maximum and minimum values excluding outliers.

Figure 14: Large dispersion across and within subsectors

%

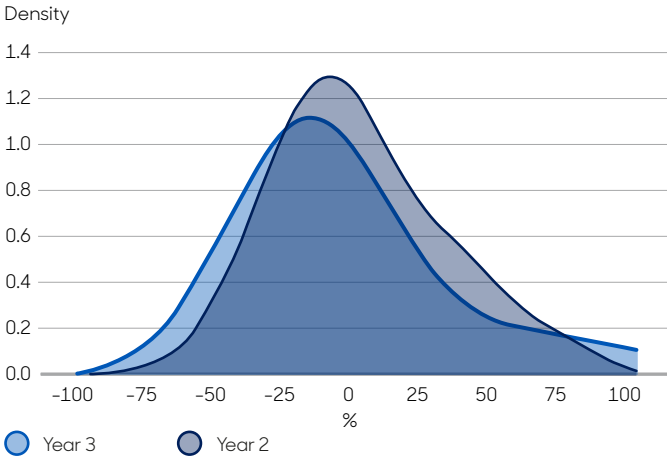


Source: abrdn, February 2023. Full Equity Universe. Stocks with a valuation uplift above 100% are not displayed. Selection of Industrials sub sectors is displayed. The box plots identify the interquartile range between the 25th and 75th percentile value of the data. The horizontal bars identify the maximum and minimum values excluding outliers.

Utilities:
Higher policy ambition impacts on carbon costs and ability to pass costs through

Utilities continues to be the only sector that shows an uplift in our mean scenario (Figure 8). However, this has been revised down from nearly 11% to 2.5%, with 56% of companies (including some of the largest by market cap) seeing a deterioration in value in comparison to 2021, and the median across the sector being negative (Figure 13). Figure 15 illustrates the shift in distribution of company-level impact between our Year 2 and Year 3 analysis.

Figure 15: Utilities sector valuation impact distribution comparison



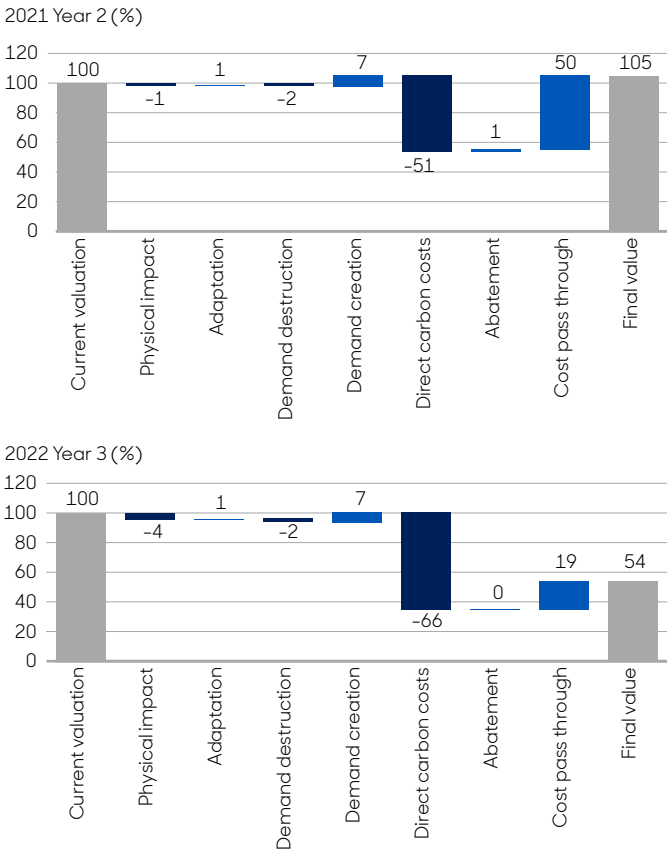
Source: abrdn, February 2023. Year 2 vs. Year 3 Probability-weighted mean scenario.

What are the main drivers?

- This is particularly driven by the US which accounts for a large proportion of the MSCI ACWI total market cap. Our scenario revisions for the US result in higher power sector carbon prices in the US prior to 2030, increasing the direct carbon costs for carbon-intensive companies and reducing their ability to pass those costs through.
- Lower carbon prices for the sector in Europe (and post-2030 in the US), compared to our Year 2 analysis, means that low-carbon companies now have a reduced competitive advantage over their more carbon-intensive peers. This results in a lower valuation up-lift than they were projected to receive in our previous analysis.

We illustrate these drivers in Figure 16 using Duke Energy, which shows a significant shift for the company. The increase in direct carbon costs from -51% to -66% reduces its ability to pass those costs through as it was previously able to do, with the competitive advantage in the market now falling in favour of its less carbon-intensive peers in the region. All five of the Utilities companies that now show the greatest impairment within the index are US based- due to large impairment from direct carbon costs and an inability to pass those costs through.

Figure 16: Comparison of NPV impacts on Duke Energy Year 2 vs Year 3



Source: abrdn, March 2023. Probability-weighted mean scenario.

Fixed income

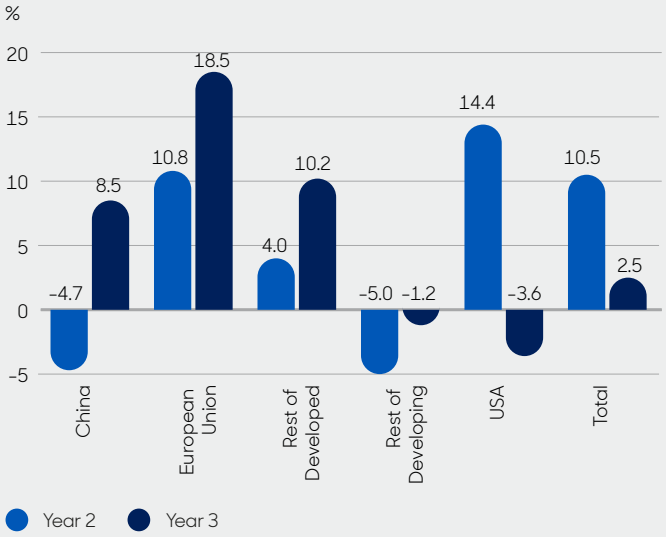
Higher direct carbon costs are also reflected in the decrease in utility bonds' NPV - by 1.9% compared to Year 2 in our mean scenario (Figure 10). There is a cap on the valuation uplifts as implied default rates cannot fall below 0. As a result, the uplift for low-carbon Utilities seen in equities, coupled with the increased sensitivity inherent in the methodology (see Appendix), is not sufficient to result in overall uplift for fixed income Utilities.

Additional insight:

The importance of regional variation in our bespoke approach

By allowing policy pathways to vary across regions we can consider the additional investment insights this provides at sector-level. This is illustrated in Figure 17 which shows that the global decrease in the Utilities sector uplift is driven by the US, which has seen the most severe reversal in impairment. The Utilities sector in other regions actually sees an uplift in this year's exercise, but the weight carried by US Utilities in the Index drives down the overall sector uplift.

Figure 17: Regional variation in Utilities sector impact

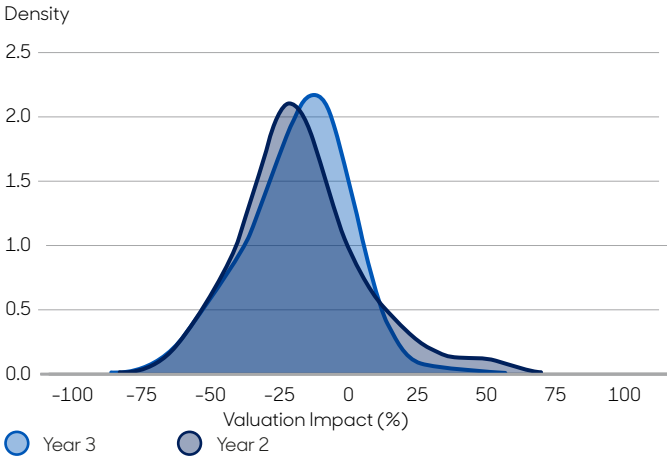


Source: abrdn, February 2023. Year 2 vs Year 3 means- Probability-weighted mean scenario.

Energy:
Negative impacts are lower as future shocks matter less due to a lower market implied growth rate

Energy remains the most negatively impacted sector due to the demand destruction and direct carbon cost associated with fossil fuels. However, the overall sector impairment has been slightly reduced in comparison to our last exercise (Figure 8). The sector mean impairment has dropped from -27.5% to -25.3%, with the distributional shift illustrated in Figure 18.

Figure 18: Energy sector valuation impact distribution comparison



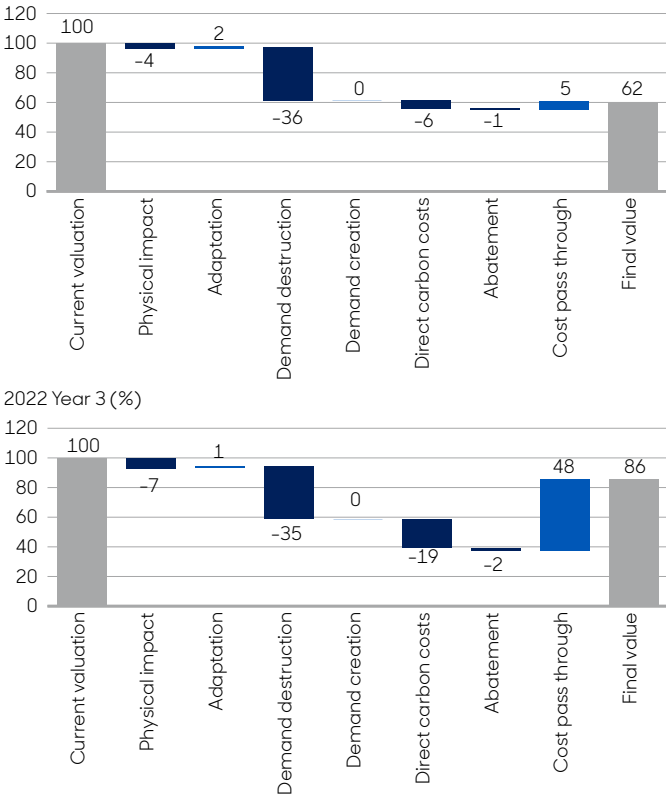
Source: abrdn, February 2023. Year 2 vs. Year 3 Probability-weighted mean scenario.

What are the main drivers?

- Energy companies' valuation significantly rose in 2022, which drove down the market-implied earning growth rate in our scenarios. This lower growth rate makes the sector less sensitive to future economic shocks relative to the short term. As a result, the sector's negative impairment due to physical risks and demand destruction were reduced overall in comparison to our last analysis.
- Whilst carbon costs have increased overall, the sector is able to pass more of that cost through given their pricing power.

The example of Devon Energy (Figure 19) illustrates these shifts in impact drivers at company level. Despite the increase in direct carbon costs, the company sees a very significant increase in its ability to pass this through- resulting in a reduction in the impairment the company receives in the mean scenario.

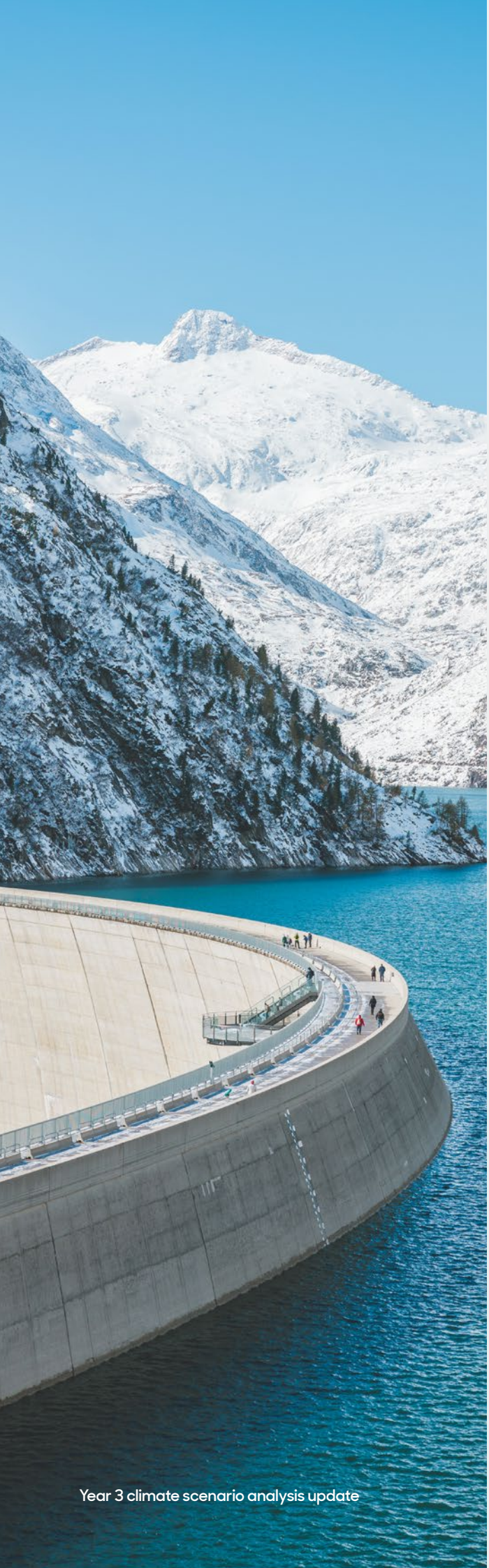
Figure 19: Comparison of NPV impacts on Devon Energy Year 2 vs Year 3



Source: abrdn, March 2023. Probability-weighted mean scenario.

Fixed income

Whilst energy sector bonds also benefit from this market dynamic, this is insufficient to counter the increased impairment from demand destruction and direct carbon cost relative to 2021 (due largely to model methodology updates - see Appendix)- resulting in more than doubling the impact on energy sector bonds' NPV (-4.2% vs -2.0% in Year2) (Figure 10).

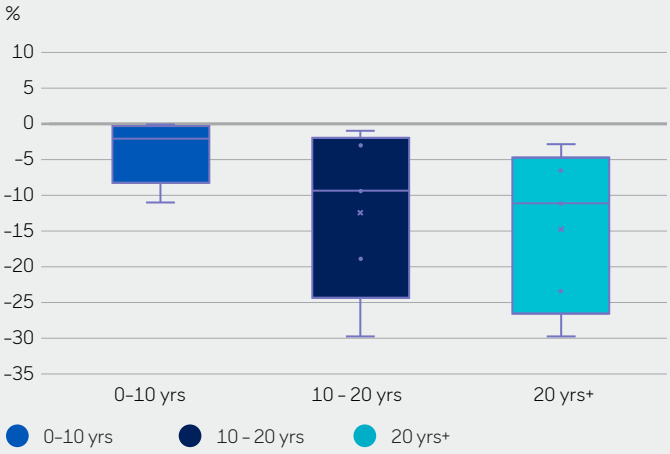


Additional insight:

Longer duration bonds experience larger impacts

As seen in the second year of analysis, longer term bonds are more impacted as physical and transition risks worsen over time. The same feature is observed this year, but with more pronounced impairments as illustrated for the Energy sector in Figure 20. The maturity of a particular company's bonds will alter how much of the climate transition an investor experiences; given we expect policy to pick up at the end of the decade, bonds with a maturity of less-than 10-years will see considerably less impact from the transition. This could, however, change if we see significant improvements in the ambition, pace, and credibility of NDCs. The large dispersion we observe, particularly with longer duration bonds, also underscores that climate change impact is mainly a micro phenomenon for fixed income too.

Figure 20: Dispersion of Energy sector bonds dependent on bond duration



Source: abrdn, March 2023.

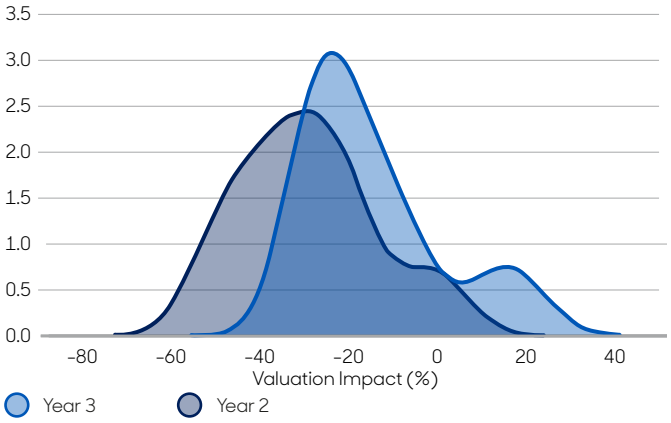
Consumer Discretionary: Increased early sector action results in uplift for autos

The reduced impairment seen in the Consumer Discretionary sector (where NPV impact has improved from -4.5% to -0.9% between 2021 and 2022) is largely attributed to uplift for auto companies (Figure 21).

What are the main drivers?

- Our baseline now comprises a lower share of Internal Combustion Engines (ICE) vehicles compared to last year, something we believe the markets are currently pricing in. Therefore, when compared to this already poor outlook for ICEs, our Probability-weighted scenario sees reduced demand destruction compared to last year.
- Secondly, the more optimistic outlook for EVs results in a greater amount of demand creation across the Auto sector.

Figure 21: Auto sector valuation impact distribution comparison

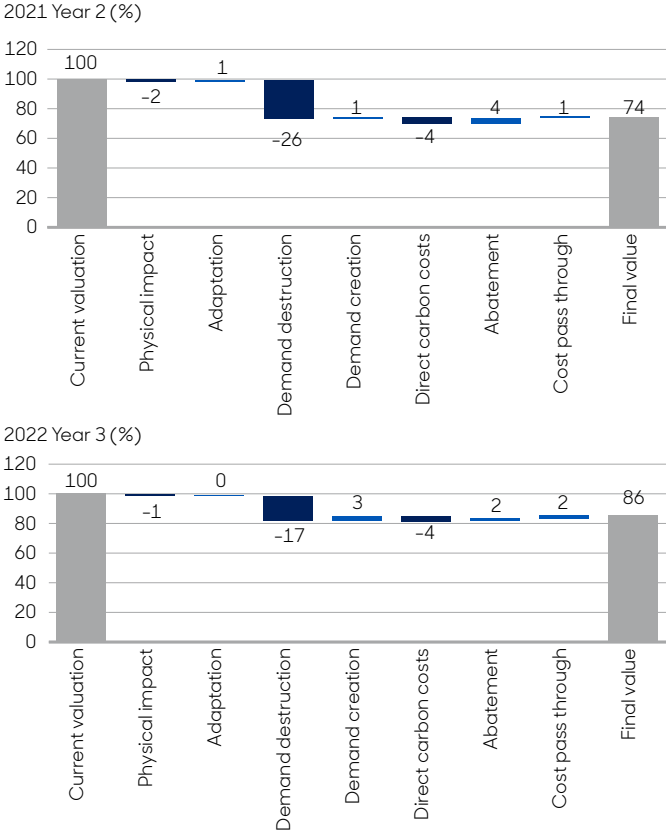


Source: abrdn, February 2023. Year 2 vs. Year 3 Probability-weighted mean scenario.

The aggregate impact for autos is now slightly positive, and 89% of auto companies have seen an improvement in their NPV in comparison to Year 2. However, most auto companies are still negatively impaired with a few specialised EV automakers with large market capitalisation skewing the aggregate impact to the upside.

To illustrate this shift at individual asset level, Figure 22 examines the automobile company Hyundai to focus on how the value impact drivers have changed. The estimated negative impairment has been almost halved, from -26% to -14%. As explained earlier, the more ambitious baseline results in a reduction in comparative demand destruction from its traditional ICE vehicle production (from -26% to -17%). As a significant producer of EVs, Hyundai also sees a small increase in demand creation thanks to larger EV sales from updated policy action, though the company is still negatively affected as most of its revenue currently comes from traditional ICE sales.

Figure 22: Comparison of NPV impacts on Hyundai Motor Co.Year 2 vs Year 3



Source: abrdn, February 2023. Probability-weighted mean scenario.

This highlights a limitation in standard climate scenario analysis. It takes the current revenue profile for a company and models the impact on these revenue proportions under future pathways. The standard analysis does not take into account the planned changes to that profile that a company may be including in its strategy. This is something we have begun to address in our approach and is outlined in the following section.

How do transition plans and our credibility assessment affect the climate scenario analysis?

Expanding our company target approach

As with most climate scenario analysis exercises, our standard approach assesses climate risk impacts from current company emissions and revenue shares, and does not incorporate future company targets, plans and strategies. For instance, the above Hyundai example (Figure 22) doesn't account for the fact that Hyundai aims at exclusively selling EVs in Europe by 2035 and reaching carbon neutrality by 2045. It is essential to quantify transition plans to determine whether companies may mitigate climate risks and to understand the extent to which they could benefit from changing their business models.

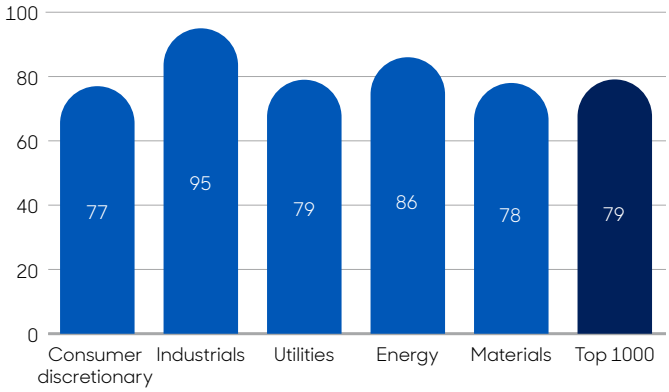
We therefore add to our standard analysis a company target approach that utilises the targets set out in company climate strategies. This analysis takes into account two key parameters in the modelling to include company targets:

- Emissions reduction targets
  - Intensity targets (tCO_2/m) are turned into a greenhouse gas (GHG) intensity pathway, assuming a linear decline in intensity.
  - Absolute targets are interpreted as intensity targets and turned into a linear reduction pathway.
- Revenue share targets - A smaller number of companies are setting targets based on shifting their product mix towards low-carbon products like electric vehicles or renewable electricity generation. This allows revenue share shifts to expand beyond the 'organic' growth of the standard modelling approach.

In Year 2 we included 390 companies in the company target approach. In our latest analysis we have extended our coverage to around 1,200 companies with targets-covering almost 2,000 equities and over 20,000 bonds. As seen in Figure 23, 79% of the 1,000 largest equities in our climate scenario tool are now covered in the company target approach. Also, while the Year 2 company target analysis almost exclusively focused on high-intensity sectors, we have expanded the analysis to assess how the inclusion of future plans would affect the largest firms across a broader range of sectors.

Figure 23: Company target analysis covers most of the largest companies

Share covered (%)



Source: abrdn, February 2023. Coverage of company target analysis for the 100 largest firms by sector.

But company transition plans shouldn't be simply taken at face value. As is the case for government targets, some companies' targets are more credible than others. This could be because of their design and integration in company plans, the policy environment in which they operate, or the readiness of the technologies that are required to transition. For this reason, **we complement the company target approach with a credibility assessment framework**.

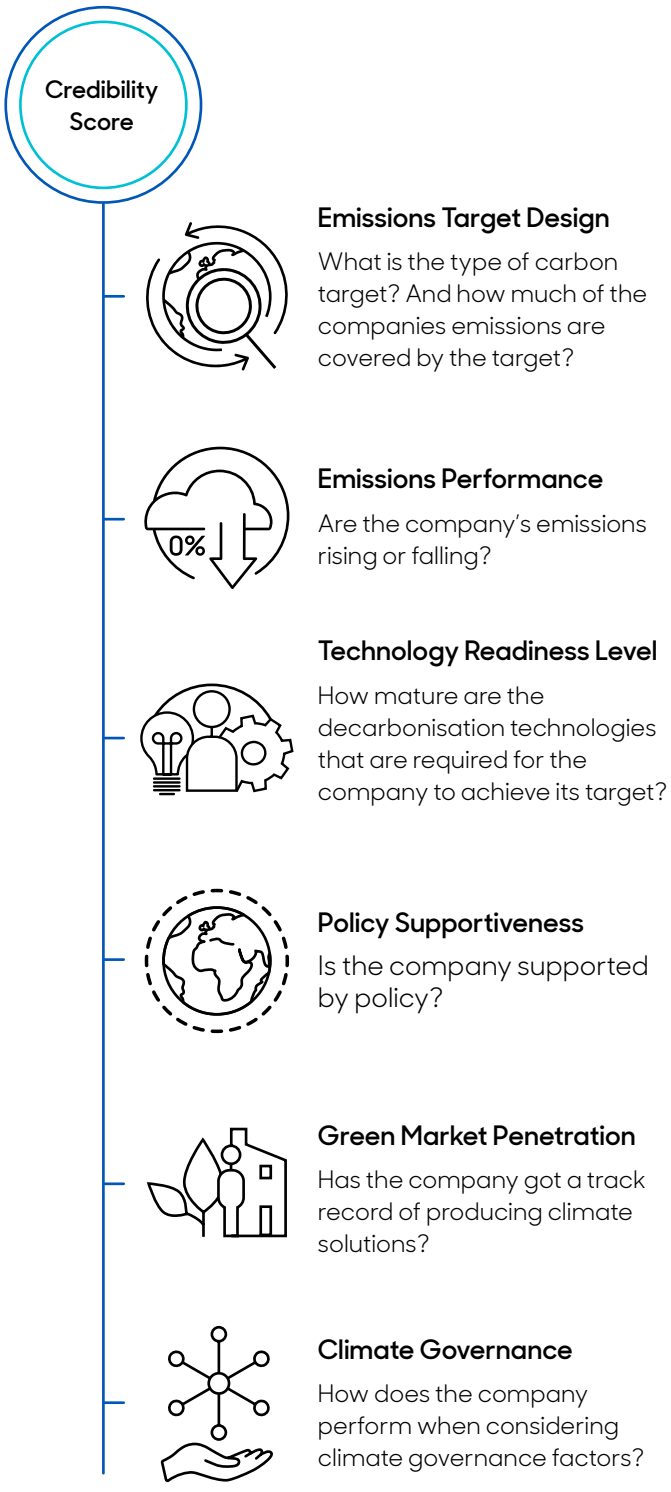
Expanding our credibility assessment

We detailed our credibility framework in our paper **Firms' climate transition plans: Building a framework to assess credibility** (and our six-factor credibility scoring framework is outlined in Figure 24). Building on this analysis, the credibility assessment now covers the approximately 1,200 companies in our expanded company target analysis detailed above.

Figure 25 summarises the sector level results for our latest credibility analysis. Utilities is the sector with the highest aggregate sector credibility score. It leads on its green market penetration (share of green revenues) and on good climate governance (TPI[4]). In contrast, the Energy sector ranks last. Most energy companies have weak emission target design and disappointing emission performance as their emissions have increased over the last two years.

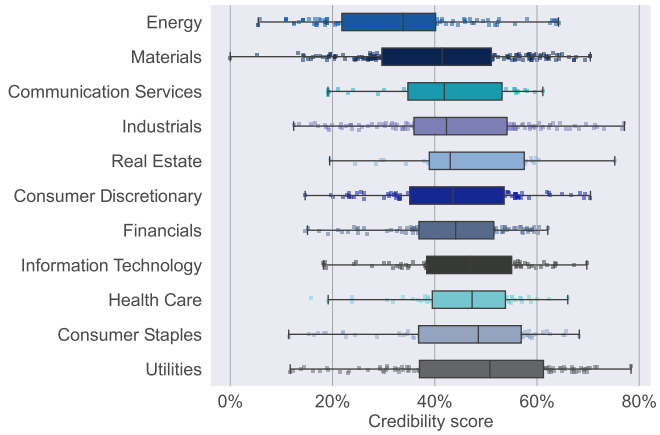
[4] Transition Pathway Initiative's Management Quality score.

Figure 24: abrdn's credibility framework schematic



Source: abrdn, October 2022.

Figure 25: Credibility score distribution by sector



Source: abrdn, February 2023. The box plots identify the interquartile range between the 25th and 75th percentile value of the data. The middle line represents the median. The horizontal bars identify the maximum and minimum values excluding outliers.

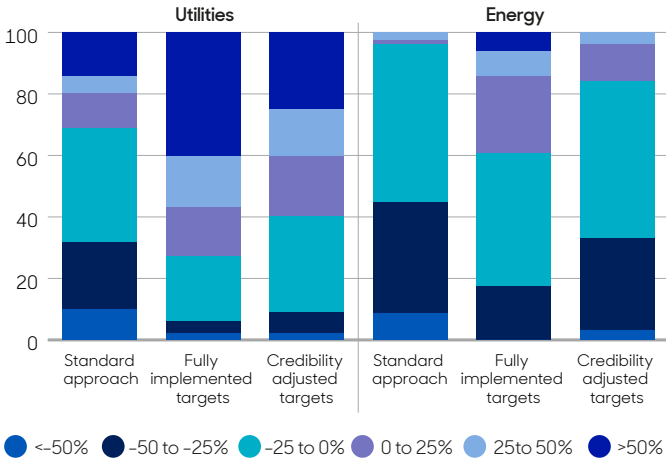
More detail on our latest analysis can be found here.

Transition plans can significantly enhance firms' NPV impacts

Nearly one fifth of all firms analysed would enjoy an uplift of over 25% if their corporate plans were fully credible. The Utilities sector in particular shows considerable potential uplift, with a large proportion of Utilities enjoying an uplift above 50% (see the comparison between the standard approach and inclusion of full targets in Figure 26). They would benefit from lower carbon costs and an enhanced cost-pass-through, given that they gain a competitive advantage against their competitors whose business models remain unchanged.

However, when looking across sectors, we also notice that most companies have a much more marginal benefit from implementing their transition plans. Many businesses are relatively unaffected by the climate transition, particularly in low-emitting sectors, and implementing targets has a limited effect on their valuation in the analysis. In addition, there are still emission-intensive companies that have no or weak transition plans. Many Energy companies are yet to set out plans to revamp their revenue mix. Therefore, even if they reduce direct carbon costs, the demand destruction channel still drives down their revenues as fossil fuel consumption declines- resulting in less uplift and approximately 60% of energy companies still showing an impairment when targets are fully implemented (Figure 26).

Figure 26: Valuation impairment with fully credible and credibility-adjusted targets



Source: abrdn, February 2023

It is important to note that in this approach, targets are analysed in isolation, and thus do not account for the way that one company's transition can affect another. This, therefore, represents an upper bound on the benefits companies can derive from dynamically transitioning. It should also be noted that the analysis does not cover the full picture- for some sectors, such as Financials, the bulk of emissions (scope 3) are not accounted for in the analysis; nor does the analysis take into account important drivers such as reputational risk.

But accounting for the credibility of targets strongly lowers the valuation uplift

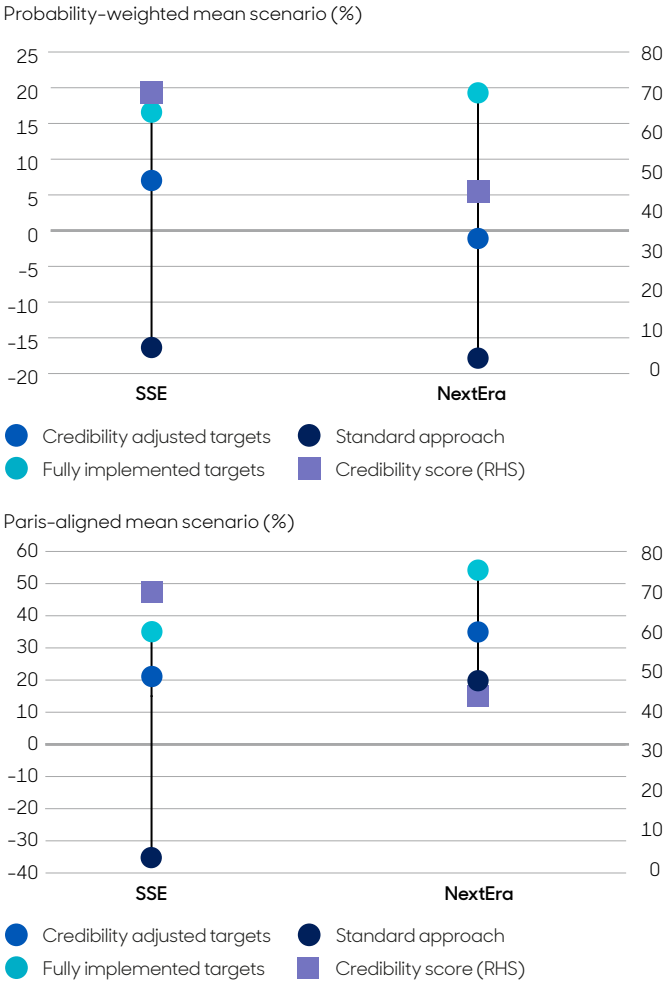
Our corporate credibility assessment framework reveals more about the likely implementation and financial impact of company transition plans. In addition to showing the impact of fully implemented company targets on the Utilities and Energy sector, Figure 26 also shows the effect of adjusting these results based on the credibility of those targets.

The variation in credibility across the sectors (Figure 25) explains why the adjustment for credibility is more pronounced for Energy than Utilities, with the share of energy companies with a positive uplift being halved once the credibility adjustment is applied (Figure 26).

Figure 25 also illustrates the significant dispersion in the credibility score within sectors, and echoes the significant dispersion we see across sectors in our core scenario analysis (Figure 13). This underscores that some companies will prove much better at exploiting the transition opportunities than their peers- which is why the incorporation of credible transition plans is so vital.

The comparative adjustment we can see within a sector is illustrated by Figure 27. Both SSE and NextEra show a similar uplift in their value in the Probability-weighted mean scenario. However, with a credibility score of 70%, SSE sees a much smaller downward adjustment in uplift compared to NextEra with a credibility score of 45%. Although NextEra scores more highly for current Green market penetration, across all other pillars SSE matches or outperforms. The scope of SSE's emission targets and their track record means they stand out from NextEra which has shown an increase in emissions over the last two years. As a US company, NextEra is also operating in a policy environment which is less supportive than that of their European peers- whilst credible climate action has significantly increased in the US following the passage of the Inflation Reduction Act, climate policy is very partisan, courts are resistant to regulatory overreach, and the fossil fuel sector continues to hold lobbying power. Given its current operating model, NextEra sees an uplift in value in the Paris-aligned mean scenario regardless of their targets. But the much greater relative uplift afforded by SSE's targets along with a smaller adjustment for credibility, results in a very significant narrowing of outcome for the two firms (Figure 27).

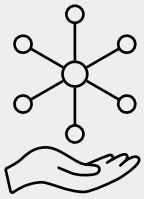
Figure 27: Comparing transition credibility for two Utilities firms



Source: abrdn, March 2023.

The initial analysis shows that credibility-adjusted transition plans can significantly improve the outlook for firms, and help identify credible transition leaders.

More detail on this analysis can be found here.



Limitations

It is important to be aware that, like any modelling exercise, our framework has some limitations.

1. Our approach rests on the assumption that the Baseline scenario is the one that the market is accurately pricing. This may not be the case. It is not clear how well market participants in aggregate understand the dynamics of the climate transition. It is also now widely accepted that markets may be inefficient in various ways, including the internal consistency of the pricing of transition risks across different firms. However, we believe that this assumption is a reasonable starting point, and it strongly simplifies what would otherwise be an intractable modelling problem.
2. Climate scenarios do not capture the impact of firm births and non-climate drivers of firm deaths. Some companies incorporated into our analysis are likely to go out of business and new firms may come into existence. Some of these new firms may be the ones to harvest the benefits of the energy transition in the same way that certain technology companies were among the major beneficiaries of the internet revolution. Similarly, the modelling doesn't capture demand for nascent technologies as their growth is uncertain.
3. The analysis relies on firm-level emissions-intensity data. While the consistency and quality of greenhouse gas-emission reporting is improving, neither disclosed emissions nor estimated emissions intensity data is yet available for some companies. For these companies, the analysis assumes that their emissions intensity is in line with the sector mean. That can lead to emissions being either significantly over- or under-estimated for these companies.
4. Our analysis focuses on the energy system incorporating the Power, Transportation, Industrial, and Buildings sectors. We don't investigate Agriculture, Forestry and Land use that account for 25% of global greenhouse-gas emissions.
5. The modelling approach assumes that the supply side structure of the oil and gas market remains similar to today. The analysis focuses on changes in demand rather than supply. All sources of oil and gas available today are assumed to be available to 2050, including shale oil, oil sands, and Middle East oil and gas. Specifically removing any of these sources through either policy (e.g. fracking bans) or geopolitics (e.g. conflict or social unrest in the Middle East) could have a material impact on the balance of supply and demand, resulting in higher prices than expected and mitigating the transition impacts on producers.
6. A smooth pricing of risk is assumed. However, impacts on market pricing may not occur linearly. For instance, tail physical impacts could result in abrupt pricing changes.
7. With regard to our company target approach, the framework currently assumes that companies can achieve their targets at no additional cost or loss of efficiency. Targets are also analysed in isolation, and thus do not account for the way that one company's transition can affect another, or the effect on overall sector/region emissions profiles. As a consequence, our current approach represents an upper bound on the benefits companies can derive from dynamically transitioning.
8. Please refer to our paper on our **corporate credibility assessment framework** for related limitations.

More generally, like any modelling exercise, ours is an approximation and simplification of the complexities of the real world. Though we think our financial exposure estimates are more robust than standard off-the-shelf or reference scenarios, important drivers of climate-related risk lie outside of the framework. Our results should therefore be seen as one input to active analysis and should always be complemented by other analysis before any financial decisions are made.

Appendix

Scenario descriptions

The following table provides a summary of the bespoke and off-the-shelf scenarios used in the project. We assign probabilities to all our bespoke and off-the-shelf scenarios which are then used to calculate our Probability-weighted mean and our Paris-aligned mean scenarios.

Table A1: Year 3 scenario descriptions

Scenario	Description
Probability weighted mean	Mean scenario based on probabilities assigned to all bespoke and off-the-shelf scenarios
Paris-aligned mean	Weighted average across all 'Paris-aligned' scenarios where warming is limited to below 2°C by 2100
Baseline (10%)	Bespoke scenario reflecting what the market is currently pricing in (September 2022, the base date for impairment). The assumption is that markets are pricing in a continuation of current policy except in circumstances where any future policy changes were already signalled, highly credible and already explicitly factored into analysts' discounted earnings expectations.Probability weighting: 10%
Limited action (REMIND)	Bespoke scenario. Limited new policy action, with a renewables tilt. Probability weighting: 20%
Limited action (M-G)	Bespoke scenario. Limited new policy action, with a gas tilt. Probability weighting: 15%
Stricter action (REMIND)	Bespoke scenario. Strict, but delayed new policy action, with a renewables tilt. Probability weighting: 12%
Stricter action (M-G)	Bespoke scenario. Strict, but delayed new policy action, with a gas tilt. Probability weighting: 9%
Early action (REMIND)	Bespoke scenario. Strict, immediate policy action, with a renewables tilt. Probability weighting: 4%
EM-DM divergence (M-G)	Bespoke scenario. Larger divergence between developed and emerging market policy action. Probability weighting: 13%
NDC (REMIND)	Off-the-shelf scenario. Current commitments for policy implementation- NDCs (Nationally Determined Contributions), with a renewables tilt. Probability weighting: 4%
NDC (M-G)	Off-the-shelf scenario. Current commitments for policy implementation- NDCs (Nationally Determined Contributions), with a gas tilt. Probability weighting: 3%
Below 2°C (REMIND)	Off-the-shelf scenario. Gradual increase in policy stringency keeping temperature increase <2°C, with a renewables tilt. Probability weighting: 2%
Delayed Transition (M-G)	Off-the-shelf scenario. Delayed implementation of Paris-aligned policy, with a gas tilt. Probability weighting: 2%
Divergent Net Zero (REMIND)	Off-the-shelf scenario. Divergent sector policies to reach net zero, with a renewables tilt. Probability weighting: 0.5%
Divergent Net Zero (M-G)	Off-the-shelf scenario. Divergent sector policies to reach net zero, with a gas tilt. Probability weighting: 0.5%
Net zero 2050 (REMIND)	Off-the-shelf scenario. Immediate Paris alignment, with a renewables tilt. Probability weighting: 0.5%
Current policy (REMIND)	Off-the-shelf scenario. Current policy action only, with a renewables tilt. Probability weighting: 0.25%
Current policy p90 (REMIND)	Off-the-shelf scenario. Current policy action only, with a renewables tilt. 90th percentile warming impact. Probability weighting: 0.25%
Forecast Policy Scenario (IPR)	Off-the-shelf scenario. A fully integrated climate scenario modelling the impact of the forecasted policies on the real economy up to 2050. Probability weighting: 4%

New insight from new metrics

Our analysis now provides us with additional metrics which provide the opportunity to expand our internal analysis and enable additional insight at asset and fund level. For example, temporal variables provide us with additional insight into when financial impacts will be most material for a company over the next 30 years.

Table A2: Additional metrics available from our climate scenario analysis

Metric	Description
Economic impact temporal	Change in net present value based on overall impact in the year in question. For equity this is based on changes in earnings or costs in the year in question; for corporate debt this assesses the impacts of climate risk factors on default probability (corporate debt) in the year in question, and assumes this change applies in all years for the life of the bond in question, based on its present characteristics.
Valuation impact temporal	Change in net present value based on overall impact beginning in the year in question with discounting applied at different time horizons. For equity this is based on changes in NPV earnings or costs, beginning in the year in question; for corporate debt this assesses rollover risk, by estimating the impact of climate risk factors on a bond's value as if it had its present characteristics but was re-priced in the year in question
Loss given default (absolute or relative)	Change in loss given default over time relative to baseline, using the Frye-Jacobs PD-LGD relationship
Credit rating change	Change in issuer credit rating relative to baseline measured in 'notches', using Planetrics' Altman ratings-based credit risk modelling approach.
Z spread change	Change in Z-spread relative to baseline, using Planetrics' Altman-ratings based credit risk modelling approach.
Drivers of total impact for fixed Income	As with equity, can obtain the valuation impact for fixed income from each driver (carbon cost, demand creation…)

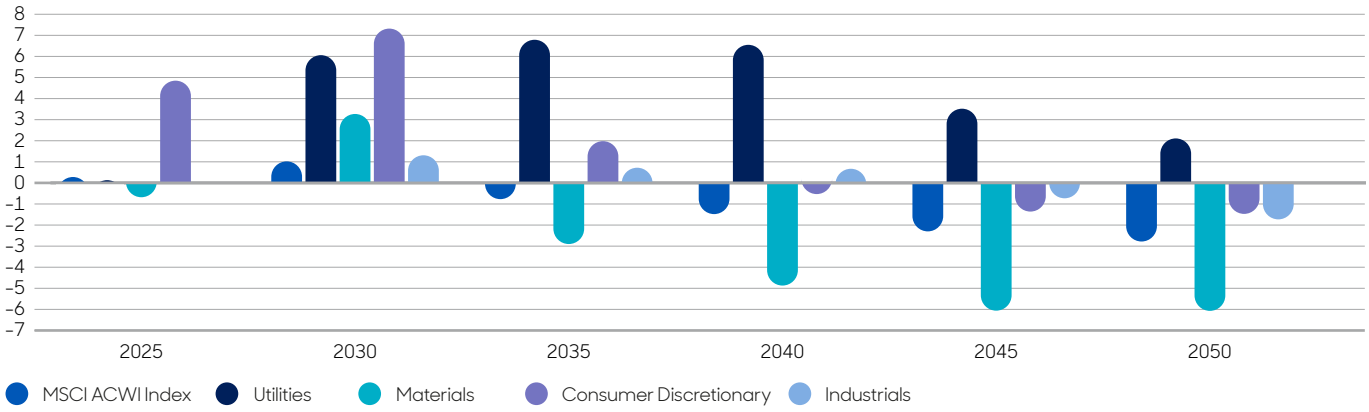
Example of new insight: The timing of earnings

Annualised analytics can often hide significant insight, namely, the way that variables change over time since policy and technological advancements can become prominent at different points in the future. Temporal metrics allow us to consider the overall change in net present valuation on specific years (e.g. what would be the annual earnings impact in 2035?) or start the analysis in specific years (e.g. what would be the valuation impairment if we only include the impacts from 2035 onwards?). **This allows us to better assess how companies would be impacted over time.**

Figure A1 illustrates the change in NPV earnings at different time periods (economic temporal impact) for key exposed sectors. As policy gradually becomes less favourable for ICE manufacturers and supports electric vehicles, the earnings for Consumer Discretionary companies (dominated by Auto companies) first increase up to 2030 and subsequently decrease. This is consistent with policy action and carbon prices stepping up in the next decade in our Probability-weighted scenario. Depending on when investors invest and divest in a given sector, we expect radically different return profiles.

Figure A1: Earnings increase up to 2030 before declining

Mean impact (%)



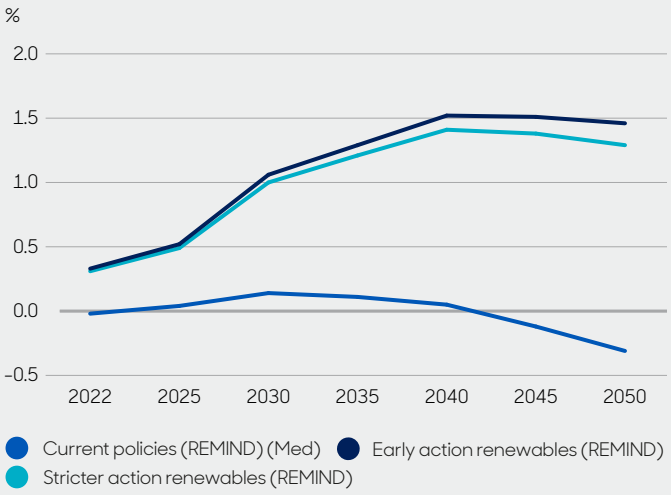
Source: abrdn, February 2023

Additional insight:

Measures of credit risk over time

Changes to companies' earnings can significantly influence the financial health of corporations, which is one key factor investors look to in assessing credit worthiness. Figure A2 shows the default risk for Autos for US Investment-Grade credit holdings. The Autos sector suffers in more stringent climate policy scenarios (Early action & Stricter action scenarios), as indicated by significantly elevated probability of default. This is due to their current reliance on fossil fuels and the projected decline in competitiveness of conventional autos in the vehicle space. Conversely, in scenarios less optimistic on electric vehicles such as in the Current policy scenario, the riskiness declines for companies with operations dependent on ICE, as they are expected to continue to expand their market share and competitiveness.

Figure A2: Changing credit risk through time for the Auto sector



Source: abrdn, February 2023. Change in marginal default probability.

Enhancements to fixed income modelling

The following enhancements have been made to the fixed income methodology this year:

- **Change in the method of mapping rating to probability of default for companies near to default.** In the previous approach, the increase in probability of default was lower than expected for companies that are projected to be near default. Following a literature review by Planetrics, for companies with a rating of C the probability of default is now explicitly set to 40% in Year 1. In addition, the rating to probability of default mapping has been adjusted so that those companies that experience a large climate shock and experience credit downgrades now have a much more responsive probability of default than in the previous approach.
- **Altman Z-score model improvement for companies where the X4 variable has a small contribution to the overall score.** In the previous approach, bond prices were under-sensitive to changes in equity shocks for outlying companies where the X4 variable (market cap/ total liabilities) had a small contribution to the Z-score. To adjust for this under-sensitivity, the modelling reverts to the median Z-score by industry for those companies.
- **Yield to maturity (YTM) replaced with a synthetic YTM that excludes credit risk.** In the previous approach, expected cash-flows were discounted using the YTM but this resulted in some double-counting of credit risk. Therefore, the updated approach uses a synthetic YTM instead (which excludes credit risk) to produce a more appropriate discount rate.

Figure A3: Flow chart of fixed income modelling methodology

Change in company equity value

- Changes in company equity value based on DCF modelling.

→

Calculation of Altman Z-score

- Full balance sheet impacts based on changes in company equity value and correlation with other credit risk factors.
- Changes in Altman Z-score based on coefficients.

→

Change in probability of default (PD) and Loss Given Fault (LGD)

- Changes in Z-scores lead to changes in credit rating.
- Changes in PD based on empirical probabilities of default for different credit rating bands.
- Changes in LGD based on Frye-Jacobs relationship and modelled changes in PDs.

→

Change in corporate bond value

- Standard bond value techniques used to translate changes in default probabilities into change in bond value.

$$V_{bond} = \sum \frac{Coupon}{(1+i+\delta)^t} + \frac{Face\ value}{(1+i+\delta)^T}$$

- Accounts for payment structure.

Source: Planetrics, December 2022.

This report has been created by abrdn drawing on selected data provided by Planetrics Ltd (which does not include investment advice). This report represents abrdn's own selection of applicable scenarios selection and/or and its own portfolio data. abrdn is solely responsible for, and this report represents, such scenario selection, all assumptions underlying such selection, and all resulting findings, and conclusions and decisions. Planetrics Ltd. is not an investment adviser and has not provided any investment advice.

Important Information

For professional and institutional investors only – not to be further circulated. In Switzerland for qualified investors only. In Australia for wholesale clients only.

Any data contained herein which is attributed to a third party ("Third Party Data") is the property of (a) third party supplier(s) (the "Owner") and is licensed for use by abrdn**. Third Party Data may not be copied or distributed. Third Party Data is provided "as is" and is not warranted to be accurate, complete or timely. To the extent permitted by applicable law, none of the Owner, abrdn** or any other third party (including any third party involved in providing and/or compiling Third Party Data) shall have any liability for Third Party Data or for any use made of Third Party Data. Neither the Owner nor any other third party sponsors, endorses or promotes any fund or product to which Third Party Data relates. **abrdn means the relevant member of abrdn group, being abrdn plc together with its subsidiaries, subsidiary undertakings and associated companies (whether direct or indirect) from time to time.

The MSCI information may only be used for your internal use, may not be reproduced or redisseminated in any form and may not be used as a basis for or a component of any financial instruments or products or indices. None of the MSCI information is intended to constitute investment advice or a recommendation to make (or refrain from making) any kind of investment decision and may not be relied on as such. Historical data and analysis, should not be taken as an indication or guarantee of any future performance analysis forecast or prediction. The MSCI information is provided on an "as is" basis and the user of this information assumes the entire risk of any use made of this information. MSCI, each of its affiliates and each other person involved in or related to compiling, computing or creating any MSCI information (collectively, the "MSCI" Parties) expressly disclaims all warranties (including without limitation, any warranties of originality, accuracy, completeness, timeliness, non-infringement, merchantability and fitness for a particular purpose) with respect to this information. Without limiting any of the foregoing, in no event shall any MSCI Party have any liability for any direct, indirect, special, incidental, punitive, consequential (including, without limitation, lost profits) or any other damages (**www.msci.com**) Morningstar ©2023 Morningstar. All Rights Reserved.

The information contained herein is intended to be of general interest only and does not constitute legal or tax advice. abrdn does not warrant the accuracy, adequacy or completeness of the information and materials contained in this document and expressly disclaims liability for errors or omissions in such information and materials. abrdn reserves the right to make changes and corrections to its opinions expressed in this document at any time, without notice.

Some of the information in this document may contain projections or other forward-looking statements regarding future events or future financial performance of countries, markets or companies. These statements are only predictions and actual events or results may differ materially. The reader must make his/her own assessment of the relevance, accuracy and adequacy of the information contained in this document, and make such independent investigations as he/she may consider necessary or appropriate for the purpose of such assessment.

Any opinion or estimate contained in this document is made on a general basis and is not to be relied on by the reader as advice. Neither abrdn nor any of its agents have given any consideration to nor have they made any investigation of the investment objectives, financial situation or particular need of the reader, any specific person or group of persons. Accordingly, no warranty whatsoever is given and no liability whatsoever is accepted for any loss arising whether directly or indirectly as a result of the reader, any person or group of persons acting on any information, opinion or estimate contained in this document.

This communication constitutes marketing, and is available in the following countries/regions and issued by the respective abrdn group members detailed below. abrdn group comprises abrdn plc and its subsidiaries:

(entities as at 28 November 2022)

United Kingdom (UK)

abrdn Investment Management Limited registered in Scotland (SC123321) at 1 George Street, Edinburgh EH2 2LL. Authorised and regulated in the UK by the Financial Conduct Authority.

Europe[1], Middle East and Africa

[1] In EU/EEA for Professional Investors, in Switzerland for Qualified Investors - not authorised for distribution to retail investors in these regions

Belgium, Cyprus, Denmark, Finland, France, Gibraltar, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, and Sweden: Produced by abrdn Investment Management Limited which is registered in Scotland (SC123321) at 1 George Street, Edinburgh EH2 2LL and authorised and regulated by the Financial Conduct Authority in the UK. Unless otherwise indicated, this content refers only to the market views, analysis and investment capabilities of the foregoing entity as at the date of publication. Issued by abrdn Investments Ireland Limited. Registered in Republic of Ireland (Company No.621721) at 2 -4 Merrion Row, Dublin D02 WP23. Regulated by the Central Bank of Ireland. **Austria, Germany:** abrdn Investment Management Limited registered in Scotland (SC123321) at 1 George Street, Edinburgh EH2 2LL. Authorised and regulated by the Financial Conduct Authority in the UK. **Switzerland:** abrdn Investments Switzerland AG. Registered in Switzerland (CHE-114.943.983) at Schweizergasse 14, 8001 Zürich. **Abu Dhabi Global Market ("ADGM"):** Aberdeen Asset Middle East Limited, 6th floor, Al Khatem Tower, Abu Dhabi Global Market Square, Al Maryah Island, P.O. Box 764605, Abu Dhabi, United Arab Emirates. Regulated by the ADGM Financial Services Regulatory Authority. For Professional Clients and Market Counterparties only. **South Africa:** abrdn Investments Limited ("abrdnIL"). Registered in Scotland (SC108419) at 10 Queen's Terrace, Aberdeen AB10 1XL. abrdnIL is not a registered Financial Service Provider and is exempt from the Financial Advisory And Intermediary Services Act, 2002. abrdnIL operates in South Africa under an exemption granted by the Financial Sector Conduct Authority (FSCA FAIS Notice 3 of 202 2) and can render financial services to the classes of clients specified therein.

Asia-Pacific

Australia and New Zealand: abrdn Australia Limited ABN 59 002 123 364, AFSL No. 240263. In New Zealand to wholesale investors only as defined in the Financial Markets Conduct Act 2013 (New Zealand). **Hong Kong:** abrdn Hong Kong Limited. This document has not been reviewed by the Securities and Futures Commission. **Malaysia:** abrdn Malaysia Sdn Bhd, Company Number: 200501013266 (690313 -D). This document has not been reviewed by the Securities Commission of Malaysia. **Thailand:** Aberdeen Asset Management (Thailand) Limited. **Singapore:** abrdn Asia Limited, Registration Number 199105448E.

For more information visit abrdn.com

GB-060423-190579-1

abrdn.com

STA0423242228-001