Climate scenario analysis: a rigorous framework for managing climate financial risks and opportunities

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Executive Summary

Climate scenario analysis is an essential activity for climate-driven asset managers

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° 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 and generate better long-term returns for clients. Asset owners and regulators are also increasingly demanding this.

abrdn's bespoke approach to climate-scenario analysis sets us apart from other asset managers

Our approach to climate-scenario analysis is motivated by the view that a rigorous and transparent methodology is essential for making sound investment decisions, encouraging positive change at the companies in which we invest and achieving robust outcomes for our clients. There are three features that jointly differentiate abrdn's climate-scenario framework from that of most other asset managers and allow us to fully integrate the results into our business strategy:

1. **Bespoke scenario design** – Climate scenarios are typically taken 'off the shelf' from expert outside agencies. While this facilitates comparability and can be useful for policy design, it comes at the expense of unrealistic assumptions about policy uniformity across regions and sectors that weaken these scenarios' usefulness for investment integration and product development. By relaxing these assumptions, we can build more plausible scenarios that better inform our assessment of climate risks and opportunities.

2. **Macro and micro integration** – Investment integration also requires a rigorous process for translating climate scenarios into financial impacts for all the assets we manage. Drawing on the expertise of our external partner, Planetrics, we do this in three stages:

   I. Our scenarios are converted into economic shocks like carbon taxes or physical damage that alters energy usage and the demand and supply of different products through time.

   II. Effects on asset value streams are then modelled as a function of firms' exposures to these shocks, their ability to react to them in terms of abatement or adaptation, and the nature of competition in their industries and thus the ability to pass on any higher costs to consumers or gain market share at the expense of worse-affected competitors.

   III. Finally, we generate impairment estimates for individual securities, using standard asset-pricing models, which can be aggregated at sector, regional and portfolio level.

3. **Probabilistic assessments** – The financial implications of climate change and the energy transition will be determined by the evolution of regulation, policy and technology. However, these drivers are difficult to forecast over long horizons. It is critical to take this uncertainty into account and update our analysis as new information becomes available. We do this by a) specifying a wide range of plausible scenarios; b) assigning probabilities to each scenario based on the political economy and economics of mitigation; c) pooling the results so that we can analyse how asset prices respond to the probability-weighted mean outcome, as well as tail outcomes; and d) updating our scenarios and their probabilities on an annual basis.

A major energy transition is taking place – it is just a question of scale, speed and composition

In terms of the future of energy, the most important takeaways from our analysis are as follows:

a) The transition to a lower-carbon global economy is highly likely to continue. Even in our probability-weighted (mean) scenario, which sees the world fall short of keeping global temperature increases below 2°, the non-renewable energy share in the global energy mix declines from 68% today to 27% by 2050 thanks to stricter policy and the increased penetration of low-carbon technologies. And under the weighted average across our Paris-aligned scenarios, that share falls even further, to 12%.

b) But the transition will be uneven across sectors and geographies. Because the politics of climate mitigation vary considerably across the major economies, and abatement opportunities vary significantly across sectors, the transition is likely to proceed at different rates. Sectorally, the power sector is the most likely to decarbonise on Paris-aligned timeframes, and the industrial and buildings sectors the least likely. Geographically, Europe has the highest probability of completing the zero-carbon transition by 2050, and the emerging-market complex the lowest, with the US in the middle.

c) Solar photovoltaics (PV) is likely to be the biggest winner from the energy transition. Even in our least favourable scenario, the share of solar in the power sector's energy mix doubles to 4% by 2050, with this increasing to 25% in our mean scenario and almost 60% in some strict-action scenarios. Onshore and offshore wind also account for a rising share of the energy mix in most scenarios, albeit with weaker growth than solar, except when pessimistic assumptions are made about future improvements in solar efficiency and storage capabilities.

d) Among the fossil fuels, the outlook for coal is especially dire while peak oil demand is likely to be just over a decade away. In our mean scenario, coal usage declines at an 0.9% annualised rate (ar) over the next 30 years and by more than 4% per annum in our mean Paris-aligned scenario. This is because it is the dirtiest fossil fuel and is penalised the most by carbon pricing and the declining cost of clean alternatives. In our mean scenario, oil demand gradually rises until the early 2030s before trailing off as the share of electric vehicles crosses critical thresholds.

e) Natural gas has a larger role to play in the energy mix, but the demand outlook varies considerably across scenarios. Our research affirms the potential for natural gas to act as a transition fuel, with usage increasing at around a 1% ar in our mean scenario. In Paris-aligned scenarios, however, its long-term outlook depends heavily on the extent to which the cost of renewable-energy technologies continues to fall rapidly and whether carbon-capture and storage technologies become more cost-competitive.

Climate risk and opportunity is largely a micro or stock-specific phenomenon

The impact of climate change on returns for aggregate global equities is very modest, a +/- 2% impact on aggregate valuation in most scenarios. This is roughly equivalent to losing one quarter of average returns on the S&P 500 over the past 50 years. Aggregate effects on regional indices are also generally modest because of their diversification.

At the sector level, global utilities is the largest winner and fossil-fuel energy the largest loser. Indeed, there is no scenario in which the global utility sector suffers negative equity and credit impairment, with upsides above 30% in most strict climate-action scenarios because of the growing demand for renewable power. By contrast, the only scenario in which the fossil-fuel energy sector does not suffer an average negative impairment is if there is no scaling up of current climate policies. Most other sectors are, on average, negligibly affected even under strict abatement scenarios because of their lower carbon intensity.

Within aggregate sectors, though, there is great dispersion across sub-sectors, firms and regions. The largest risks and opportunities are concentrated in the energy, utilities, industrials, materials and information technology sectors. Renewable-energy-based utilities significantly outperform coal utilities; copper and lithium miners do much better than coal miners; and oil-equipment manufacturers lose out to battery, wind-turbine and solar-panel manufacturers.

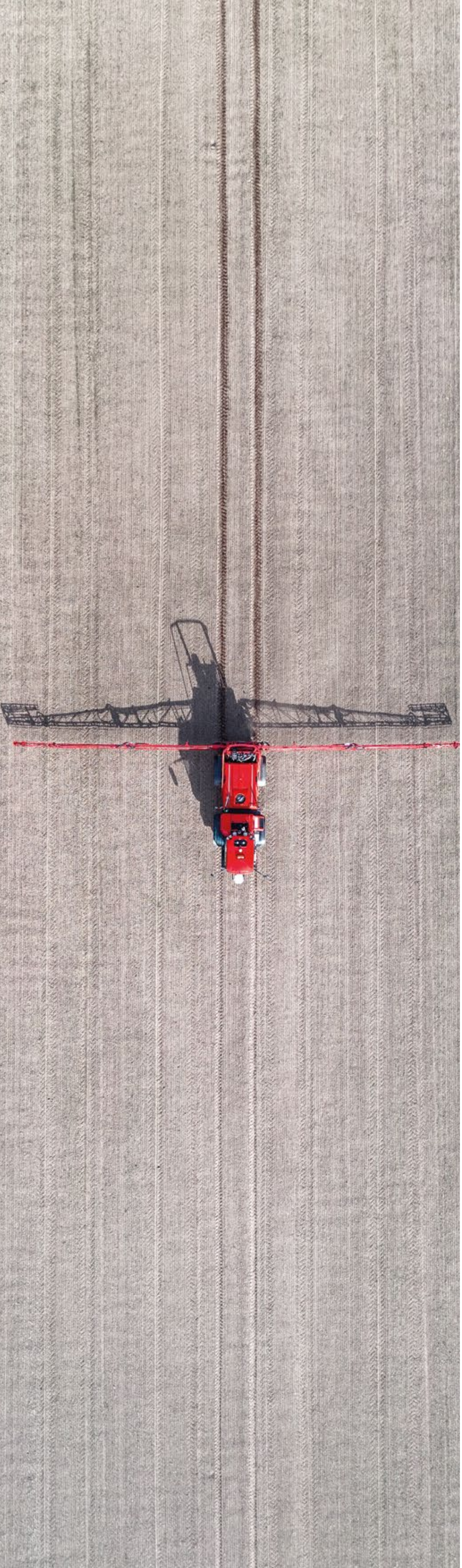
This implies a large opportunity to draw on scenario analysis to add alpha to actively managed investment portfolios. There are also more systematic opportunities for investment strategies that tilt towards climate-transition winners and for thematic climate-solutions portfolios.

The takeaways for listed credit securities are similar to those of equities, with a few important differences. The impacts of the energy transition are concentrated in the same sectors, and, as with equities, dispersion within sectors and regions is much higher than across them, with only modest aggregate impacts at the index level. However, because credit is higher up the capital structure than equity and the effective duration of many credit instruments is lower, the magnitude of credit impairments for a given firm are also generally lower.

The insights from our analysis are being embedded throughout the business

In the coming months we will fully integrate our climate-scenario framework and insights into our business strategy, the key stages of our investment process and the development of climate-driven solutions to deliver superior outcomes for our clients. This will include the following:

a) Integrating the results into active stock selection by asking critical climate-related research questions that are informed by our scenario analysis. Our answers will complement our broader company research, including our assessment of the credibility of firms' transition strategies. This in turn will allow us to construct portfolios that are resilient to different plausible climate pathways.



b) Embedding scenario analysis into our approach to stewardship. Where material climate risks are identified, we will engage with companies to understand what actions they are taking to mitigate them and encourage firms to undertake their own analysis. This is aligned with our core principle to disclose on climate change in line with the Task Force on Climate-related Financial Disclosures (TCFD) framework. Where risks are not well managed, this will inform our investment decisions.

c) Fully integrating climate risk and opportunity into our strategic asset-allocation framework – our probability-weighted mean approach is particularly valuable for improving mean-variance optimisation.

d) Developing a wide range of innovative climate-change (including net zero) solutions for our clients. This includes climate-tilted benchmarks – which outperform standard equivalents in most of our scenarios – as well as climate-enhanced products that are focused on climate solutions and transition leaders. The objective is to protect clients from climate-related risks, allow them to benefit from climate-related opportunities and have a real-world impact on decarbonisation.

Climate scenario analysis is a journey rather than a one-off project. Our future work programme is far ranging. We will update the analysis on an annual basis, taking into account changes in policy, technology and the structure of markets. We will expand our analysis into the full range of private assets and undertake more granular dives into the drivers of change within sectors like energy and utilities. And we will be working to incorporate dynamic business change into our analysis, improving our ability to identify companies that are making a success of the transition.

This paper focuses more on the financial impacts of climate transition risk rather than physical risk. Physical impacts were fully incorporated into our stage-1 modelling, but we intend to enrich our analysis in the next stage of our programme. We will do this by increasing the number of physical risk scenarios, allowing for physical 'tipping points' to occur at lower levels of temperature change and expanding the range of assets subject to physical damages while exploring the important issue of climate adaptation in depth. We will publish our insights in a follow-up paper in late 2021, with a focus on the implications for real estate and infrastructure assets.

"Our approach to climate-scenario analysis is motivated by the view that a rigorous and transparent methodology is essential for making sound investment decisions, encouraging positive change at the companies in which we invest and achieving robust outcomes for our clients."

Part 1: Scenario analysis: an essential activity for climate-driven asset managers

Asset managers have a responsibility to all their clients to understand how climate change impacts the value of their investments. To do that, we need a good understanding of the transition and physical risks to which economies and companies are exposed. Given the uncertainty as to how policies, technologies and physical impacts will unfold in the future, we need a forward-looking, quantitative assessment of the potential impacts to inform our investment decisions. That is precisely the purpose of climate-scenario analysis.

1.1 The desired outcomes underpinning our approach to climate-scenario analysis

A number of desired outcomes provide clear principles for developing our cutting-edge approach to climate-scenario analysis. These are the desired outcomes:

1. Generating insights to integrating climate-related risks and opportunities into our investments

We are seeing the physical effects of climate change unfolding around us. This includes record temperatures, more intense and longer-lasting wildfires, and severe storms and flooding. These will only become more frequent and severe as the concentration of greenhouse-gas emissions in the atmosphere increases. Physical climate risk refers to the disruptive impact of these environmental changes on economic infrastructure, commercial and residential buildings, and the operations of firms, including their supply chains. Each has the potential to negatively affect the income streams of the owners and insurers of these assets, as well as their fair price.

1. **Generating insights that enhance the integration of climate-change factors into decision-making and improve investment performance**
2. **Developing sophisticated climate solutions to meet growing client demand for supporting the low-carbon transition**
3. **Meeting current and future regulatory demand, as well as providing transparency through TCFD reporting**
4. **Demonstrating climate leadership through our sophisticated, bespoke approach to climate-scenario analysis**

Transition risk relates to actions taken by governments and private actors to mitigate physical climate change. Measures such as carbon taxes, emission-trading schemes, renewable-energy targets, vehicle-emission standards and building-emission codes are all aimed at reducing the carbon intensity of economic activity. And as they shift the energy mix from high-carbon to low-carbon technologies, they also significantly alter the income streams of asset owners and thus the price of affected assets today.

The main physical and transition risks and opportunities of climate change are illustrated below (see Figure 1). They are also explored in further detail in our earlier white paper 'Investing in a changing climate'.

Given the wide-reaching scale of the physical and transition risks of climate change, it is impossible to invest soundly without rigorous ways of measuring, analysing and then mitigating them in investment decisions and portfolio construction. It is also important to take a forward-looking view to understand how the risks and opportunities of climate change may impact the value of our investments under different scenarios. Incorporating these critical insights into decision-making helps us build more resilient portfolios and enhance investment returns.

2. Developing sophisticated climate solutions to meet growing client demand

Client demand for sophisticated climate solutions and support with scenario analysis is growing rapidly. This may be driven by regulatory pressure, the desire to clearly understand the resilience of investments to different pathways or indeed the desire to align portfolios with climate goals and contribute to the achievement of the Paris Agreement goals. The Net-Zero Asset Owner Alliance, for example, was established in 2019 and represents investors with over $5 trillion of assets under management, all of whom have committed to aligning their portfolios to being net-zero by 2050.

Developing climate-driven investing strategies and solutions is a core part of abrdn's business strategy to enable our clients to achieve their long-term climate-related goals. Climate scenario analysis is an important input to that process. The financial implications of different pathways and resulting 'winners and losers' can help identify opportunities. This can shape the development of client solutions such as climate-focused products and climate-tilted benchmarks.

"Given the wide-reaching scale of the physical and transition risks of climate change, it is impossible to invest soundly without rigorous ways of measuring, analysing and then mitigating them in investment decisions and portfolio construction."

Figure 1: The core dimensions of climate risk and opportunity

Transition to low-carbon economies		Physical impacts of climate change	
Risks	**Opportunities**	**Risks**	**Opportunities**
Policy Technology Market Legal Reputation	Renewables Energy efficiency Electrification of transport Innovative technologies Carbon removal	Extreme weather and gradual change in temperatures Disruption to: • Business operations • Suppliers • Customers	Adaption and building resilience through: • Infrastructure • Technology • Water, food and soil management

Source: abrdn, Investing in a changing climate, Oct 2019.

3. **Meeting regulatory demands and providing transparency through TCFD reporting**

abrdn is a supporter of the TCFD framework, which is a best-practice industry standard for disclosing the risks and opportunities related to climate change and how these are managed. It is a core TCFD requirement for companies to assess the resilience of their business strategy to a range of possible climate pathways using climate-scenario analysis.

Disappointingly, the 2020 TCFD status report highlighted that only 7% of those reporting on TCFD included an assessment of climate scenarios. At abrdn, we have included the initial results of our climate-scenario analysis in our first TCFD report in 2020, and we encourage others to do the same. Climate disclosures will no longer be optional in the future, because regulatory pressures are increasing to demonstrate how climate-change risks are rigorously assessed and factored into decision-making – as the following examples show:

- The UK was the first G20 country to make TCFD disclosure mandatory by 2023 (2025 at the latest for some companies), making it the second country in the world after New Zealand to do so. This includes disclosure on climate-scenario analysis.
- In the EU, the Sustainable Finance Disclosure Regulation comes into effect in March 2021 and requires firms to describe the manner in which they integrate sustainability risks, including climate change, into investment decisions. This includes the assessment of the likely impacts of sustainability risks on the returns of a product. Climate scenario analysis is a valuable process to determine that impact.
- The Network for Greening the Financial System (NGFS) represents over 60 central banks and has been established to enhance the role of the financial system in managing climate risks and mobilising capital for the low-carbon transition. In June 2020, the NGFS published recommendations for central banks related to conducting climate-scenario analysis in order to assess the resilience of the financial system to different climate pathways.
- In the UK, the Prudential Regulation Authority published a supervisory statement in 2019 making the requirement for climate-scenario analysis mandatory for banks and insurers. We expect regulators in other regions with high climate ambitions to follow.
- The International Financial Reporting Standard has issued a consultation about incorporating climate-change disclosures into financial accounting as standard to demonstrate how climate risks have been incorporated into financials.

Climate scenario analysis is therefore critical for being able to meet the growing demand for climate disclosures outlined above in a robust, transparent manner.

4. **Demonstrating climate leadership through our bespoke approach**

We have taken a market-leading, proprietary approach to building and using climate scenarios that allows us to bring our own research-driven political, policy and technology insights into the analysis. It challenges the simplified assumptions of some off-the-shelf climate scenarios, thereby permitting us to generate more plausible 'bespoke' scenarios. These reflect our differentiated views across regions and sectors with input from our investment desks, research teams and senior stakeholders.

We have also assigned probabilities to the range of scenarios analysed. This enables us not only to consider the impact of individual and tail scenarios, but also to incorporate expected financial impacts into our decision-making based on probability-weighted expectations for the future. Probabilities are reviewed and updated as policies and technologies evolve over time.

By taking this proprietary approach, we can be more confident about embedding climate-scenario analysis into our investment, stewardship and product-development toolboxes, differentiating ourselves from peers and demonstrating leadership in considering the impacts of climate change on investment risks and opportunities.

1.2 Delivering the project with the right resources and partner in place

To deliver climate-scenario-analysis capabilities effectively and achieve the desired outcomes, the right resources needed to be in place with the relevant knowledge and skillsets to enable decision-making. Our core team consisted of representatives from different business teams and a cross-asset-class working group to bring micro and macro views to the process in a highly collaborative way.

Because of the complexity, cost and resource-intensity of developing in-house climate-scenario-modelling capabilities, we decided early on to work with a market-leading external partner whose methodology was holistic, flexible and robust. We did not want an 'off the shelf' or 'black box' modelling approach that we could not fully understand or influence. And we wanted an approach that gave us the ability to define inputs and override implausible assumptions.

To compare solution providers and select the one that most met our needs, we used a list of questions (see Table 1) to assess solution providers against our requirements. The solution assessment resulted in the selection of Planetrics (a Vivid Economics company) as our partner of choice.

Table 1: Assessment criteria for climate-change scenario-analysis solutions

Category	Assessment questions
Breadth	Which climate scenarios are available to use? What time horizons are available for the analysis? What is the scope of the analysis? · Physical and transition risks? · Macro and micro? · Qualitative vs quantitative? · Supply-chain impacts and markets?
Depth	How deep is the asset-class, sector and security-level assessment? · Exposure, sensitivity and adaptive capacity? · How much focus is put on modelling in high-emitting sectors? · How granular is the data on demand? · Is pricing of energy at the country level considered?
Rigour	What is the modelling methodology? · How do you link micro and macro factors? · What data sources are used?
Flexibility	· How transparent are the inputs and assumptions? What is not visible? · Is there the ability for us to change assumptions? · Can we integrate climate scenarios into our own forward-looking models?
Operating model & cost	· What is the operating model? (e.g. data ownership, resources, timelines) · What are the charging model and expected annual cost?

Our climate scenario analysis exercise in 2020 focused on three asset classes: listed equities, listed credit and real estate. Our analysis included an assessment of transition and physical risks for companies, but of physical risks only for real estate because of data limitations. The results of our analysis of real estate are not presented in this paper because a more comprehensive impact assessment of different climate pathways on real estate, and physical risks, is planned in 2021 and will be presented separately.

It is important to note that this paper focuses more on the financial impacts of climate-transition risk than those of physical risk. Physical impacts were fully incorporated into our stage-1 modelling, but we intend to enrich our analysis in the next stage of our programme. We will do this by increasing the number of physical-risk scenarios, allowing for physical 'tipping points' to occur at lower levels of temperature change, expanding the range of assets subject to physical damages and exploring the important issue of climate adaptation in more depth. We will then publish our insights in a follow-up paper in late 2021.

This white paper presents the insights gained from our bespoke approach to climate-scenario analysis and outlines how these are being used to deliver enhanced outcomes for our clients. The rest of the paper is structured as follows:

- **Section 2** outlines the building blocks of climate-scenario analysis and explains the rigorous approach applied to get from scenarios to financial impacts on assets.
- **Section 3** outlines our bespoke, probabilistic approach that goes beyond the usage of standard off-the-shelf scenarios and is an important differentiating factor.
- **Section 4** presents the key insights obtained from our climate-scenario analysis with a focus on the importance of dispersion to identify climate winners and losers.
- **Section 5** explains how these results are integrated into our investment processes and solutions to deliver enhanced outcomes for our clients.

Part 2: From scenarios to asset prices: the importance of a rigorous approach

Our climate-scenario analysis is built around the following four-step framework (Figure 2):

1. Identification and design of the climate scenarios relevant for assessing the different dimensions of climate risk and opportunity. Our unique 'bespoke' approach to scenario design is explained in more detail in the next chapter.
2. Translation of these scenarios into a series of economic shocks within an energy systems model. These shocks incorporate direct impacts like carbon taxes or physical damages to infrastructure, and indirect impacts like changes to commodity prices and patterns of demand.
3. Estimation of the effect of these shocks on asset value streams. These effects take into account the nature of assets' exposure to different types of shock, the action taken by companies to adapt to or mitigate that exposure, and the nature of competition within an industry.
4. Conversion of these asset-value-stream projections into 'fair value' impairment estimates, based on standard capital-asset-pricing frameworks.

2.1 Translating scenarios into impairment estimates for individual securities

A stylised example can be used to help illustrate how the four-step framework works in practice.

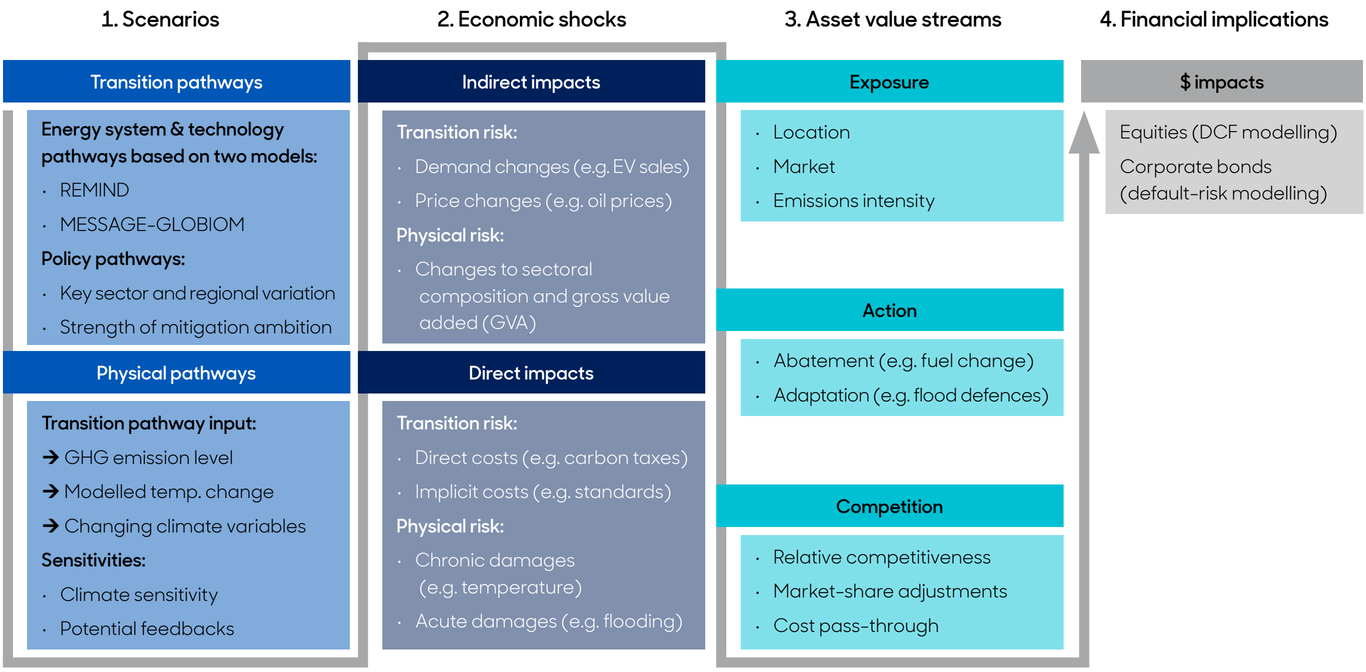
Assume we are interested in the climate-related risk facing two fictitious utility companies within the same regulatory jurisdiction:

- CoalGenCo, which is heavily reliant on fossil-fuel generation; and
- RenewCo, which draws only on renewable energy.

To simplify things further, assume we are only interested in the impact of two 'tail' risks (step 1 in our framework):

- Scenario 1 in which global policymakers take sufficient steps to limit the increase in global temperatures to 1.5° above pre-industrial levels by 2100, with action beginning immediately; and
- Scenario 2, in which current climate policies are maintained, and climate change continues more or less unchecked, resulting in warming in excess of 3° by the end of the century.

Figure 2: The building blocks of climate-scenario analysis



Source: based on Planetrics framework, January 2021.

These two scenarios will have very different relative implications for CoalGenCo and RenewCo, and thus the fair value of the two firms today. Note that in this framework, all changes in earnings and value are calculated relative to a pre-determined baseline in which we assume the market is pricing in a moderate scaling up of climate policies over time, but not to the extent required to limit temperature increases to 1.5°.

Under Scenario 1, there is a small global carbon-emissions budget available to limit climate change to 1.5°. That in turn implies that very broad-based and stringent policy and regulatory steps are taken to curtail emissions. In our models, which assume that countries implement least-cost abatement measures, this implies the introduction of high explicit (or implicit) carbon prices across all sectors and geographies, which also rise steeply over time. These, and the changes in patterns of demand and the prices of inputs and outputs they are associated with, will be the key economic shocks (step 2 in our framework) that are modelled in this scenario.

In this scenario, CoalGenCo does very poorly relative to the baseline while RenewCo does very well. That is because CoalGenCo is subject to much larger direct and indirect cost shocks, which it cannot fully pass on to end-users because it is competing for market share with cleaner firms. RenewCo, on the other hand, benefits from final prices for end-users rising without having to absorb any additional costs, and its market share would be likely to rise significantly over time.

CoalGenCo can attempt to counteract the impact of this direct carbon pricing on its asset value streams (step 3 in our framework) by deploying abatement measures that improve its efficiency, but it would also need to invest in expensive capital projects such as carbon capture and storage (CCS) technology and/or increase the renewable share of its portfolio to more radically reduce the direct carbon costs through abatement. There is also a high chance of CoalGenCo's assets being stranded as the demand for its output declines relative to RenewCo.

The upshot is that under Scenario 1, the future expected earnings of CoalGenCo will be much lower than for RenewCo, justifying a lower valuation relative to the baseline we assume is priced into assets (step 4 in our framework).

Under Scenario 2, however, there is effectively nothing limiting emissions. They therefore continue to rise in line with economic growth and any decarbonisation that relates to existing policies, private behaviour and technology changes that are independent of climate policy. Global carbon prices remain low under this scenario and do not increase over time. As a result, CoalGenCo does not face a cost shock or policy incentives to decarbonise its business that would negatively affect its earnings. The demand for its output would also be relatively unaffected.

The implications, then, of this scenario are the reverse of Scenario 1. Future expected earnings for CoalGenCo would be stronger than assumed in the baseline, justifying a much higher valuation than under Scenario 1. The fair value of RenewCo would decline, however, because its market value was predicated on policy actions scaling up over time.

So far, we have focused on the transitional impacts on the two companies under each scenario. But Scenario 2 is primarily a physical-risk scenario. Both chronic (gradual, incremental) and acute (sudden, extreme) climate-change impacts could weaken the productive capacity of our two utility firms. Depending on their precise location and vulnerability, their generation and distribution infrastructure may be exposed to increasing acute risks from flooding, storm damage and sea-level rises. These would also influence the economic shocks to which the firms are subject in this scenario.

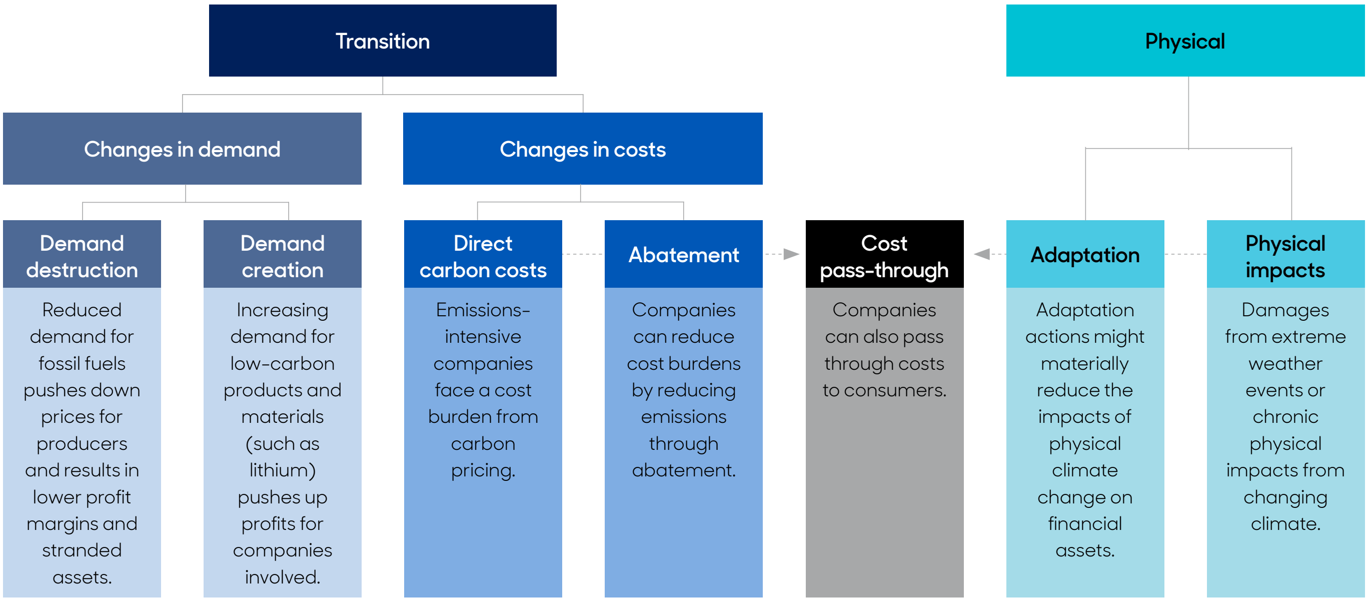
That in turn would result in damage costs, disruption to operations and the need for investment in resilience measures, translating into weaker earnings and a lower fair valuation of each company. Indeed, under extreme conditions in which the locations of the two companies had very different exposures to physical climate change, the benefits CoalGenCo might enjoy from avoiding transitional risk could be more than offset by physical-risk effects.

The impacts on asset value streams that result from these economic shocks, asset-level responses and market dynamics are summarised in Figure 3. These seven distinct impact channels provide us with a clear way to interpret the factors that underpin the asset-level impairment or the uplift generated by the scenario analysis.

2.2 Decomposing security impairments into their economic and financial drivers

For investors, the value of climate scenarios lies primarily in their implications for security prices. How will a company's share price perform in a 1.5° scenario compared with a 3° scenario? How will these scenarios impact the price of its bonds? What are the implications for my portfolio as a whole? Our scenario tools provide a strong starting point for answering these questions.

Figure 3: The seven impact channels of climate-scenario analysis



Source: Planetrics, January 2021.

Drawing on the Planetrics framework, our approach has two key components that simply the exercise significantly:

- First, we estimate the impact of a given scenario 'relative' to the baseline scenario. This might, for example, produce an estimate for the earnings growth of our fossil-fuel intensive utility to be half as much in our stylised rapid-decarbonisation Scenario 1 as it would have been in the baseline.
- Second, we assume that the growth rate for earnings in the baseline is accurately reflected in current market prices.

This second assumption allows us to estimate the earnings growth associated with the baseline scenario for each company without having to do thousands of company-specific long-term earnings forecasts. In simplified terms, this is achieved by reversing the standard discounted-cash-flow equation.

$P= D/(r-g)$ is reorganised to $g=r-D/P$

The share price (P) is the market price at the point the baseline scenario is defined. The discount rate (r) is sourced from consensus estimates of sector discount rates; and the dividend level (D) is generated from sector earnings data and plausible assumptions about payout ratios. Together, these two steps mean that we can estimate the earnings growth rate for any company in any scenario.

Again, take our stylised example. We take the earnings growth implied by the current market price in the baseline scenario and multiply it by the difference in relative growth rate in Scenario 1. An earnings growth rate of 6% becomes a growth rate of 3% in a scenario where earnings growth is 50% lower. This new technique also allows us to estimate the fair-value price in any scenario by reversing the equation described above.

This approach is used for equities and equity-like assets. For corporate bonds, changes in equity valuations are translated to changes in bond-default risk using standard techniques.

"These seven distinct impact channels provide us with a clear way to interpret the factors that underpin the asset-level impairment or the uplift generated by the scenario analysis."

2.3 Limitations: what is not captured in the analysis?

We believe that our approach represents a significant advancement in the field of climate-scenario analysis, giving us greater confidence in the results and their applicability to real-world investing. However, it is important to be aware that, like any modelling exercise, our framework still has limitations, implying that the results cannot be applied mechanically to investment decisions. The following are among the most important of these limitations:

- 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 – undergoing periods of irrational exuberance or unjustified pessimism. However, we believe that this simplifying assumption is a reasonable starting point, and it radically simplifies what would otherwise be an intractable modelling problem. In defining our baseline, we have undertaken consultation with our investment teams on what they think the market is pricing and have made adjustments accordingly.
- The modelling approach does not currently take into account the potential for dynamic business changes in response to different types of climate risk. This is a key reason why the impairment estimates should be considered starting points for climate-related stock selection and portfolio construction, rather than an end point – and why active management is important. We discuss the implications of this limitation – and its implications for transition companies in particular – later in the paper. We also plan to formally incorporate transition strategies into future scenario updates.
- Climate scenario analysis also cannot capture the impact of firm births and non-climate drivers of firm deaths. Over a 30-year period, some companies incorporated into our analysis may go out of business and new firms may come into existence. And some of these new firms may be the ones to harvest the benefits of the energy transition in the same way that Google or Amazon were among the major beneficiaries of the internet revolution.
- There are gaps in what the models were able to capture in the Year 1 exercise. For example, modal shifts in patterns of transportation demand were not fully accounted for. This may lead us to underestimate the positive effects of the energy transition on low-carbon transport providers. The Year 1 iteration of models also does not incorporate any structural changes to the economy and patterns of energy demand and supply relating to the Covid pandemic. We were also unable to capture the potential impact of technologies – like hydrogen power – that are at very early stages of development. We will be addressing these limitations in future updates of our analysis.
- Climate scenario analysis is heavily reliant on high-quality, firm-level emissions-intensity data, including for the different components of a company's activities. 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 individual companies. Carbon-accounting rules are also not fully harmonised, even for listed companies. For affected firms, we take these data limitations into account in our investment processes.
- Agriculture, forestry and land use account for 25% of global greenhouse-gas emissions. But our analysis focuses on the energy system incorporating the power, transportation, industrial, and buildings sectors. Transition and physical effects on agriculture, forestry and land use are likely to be significant, though they are less important from an investment perspective because they represent a very small share of the investable universe.
- The modelling approach assumes that the supply-side structure of the oil and gas market remains similar to today. The climate-scenario analysis focuses on changes in demand, not supply. All sources of oil and gas available today are assumed to be available to 2050, including shale oil, oil sands, Russian oil and gas, 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 those expected today and mitigating the transition impacts on producers.
- Finally, as outlined earlier, physical climate risk is incorporated into our analysis, but not deeply enough for us to be confident that we have appropriately captured all the relevant risks and channels of impact. Addressing this is a priority for future work.

Part 3: abrdn's unique bespoke and probabilistic approach to building climate scenarios

In the previous two chapters, we set out the rationale for undertaking climate-scenario analysis and the basic contours of our approach. This chapter sets our approach to the critical first step in the framework: choosing, designing and assigning probabilities to different climate scenarios. Our approach is founded on three core beliefs:

- The political economy and economics of climate-change mitigation will continue to vary significantly across geographies and sectors.
- 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.
- Given beliefs (1) and (2), any approach to scenario analysis 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 about the probable absolute and relative impact of mitigation policies across the universe of securities and indices in which we and our clients invest.

As a result, we have developed an approach – with Planetrics – that allows us to design a wide variety of 'bespoke' scenarios that do the following:

- Avoid the implausible assumptions of uniformity that dominate mainstream climate-scenario analysis;
- Permit us to approach the investment implications of climate change probabilistically, by generating a weighted mean across the scenarios and identifying the distribution of risks around that mean;
- Facilitate regular adaption of assigned probabilities as the underlying political, policy and technology drivers of the different scenarios change.

3.1 The building blocks for scenario construction

Before we discuss the rationale for the scenarios we have chosen and their probabilities, it is worth setting out the constraints that govern our choice set.

Scenario range

Our exercise includes 15 scenarios in total – including our baseline and the probability-weighted mean across each of the individual scenarios. This is made up of seven off-the-shelf scenarios where all policy and technology parameters are taken as given, and eight 'bespoke' scenarios that allow us to vary the policy parameters by geography and sector across important dimensions.

We primarily use the off-the-shelf scenarios to benchmark our analysis against those most commonly modelled by regulators and other users of climate scenarios. But because of the unrealistic policy assumptions underpinning those off-the-shelf scenarios, the bespoke scenarios will drive most of our analysis of climate-related risks and opportunities, and the investment decisions derived from that analysis.

We draw on a much larger number of scenarios than is common in other exercises. Although this makes our exercise less parsimonious, it has the major advantage of allowing us to identify and analyse the consequences of a much larger proportion of the long-term climate-related probability distribution.

Energy-systems models and technology pathways

Modelling climate risk requires the use of integrated assessment models (IAMs) that embed different assumptions about energy systems in different countries and sectors, as well as the technology pathways that shape their evolution.

Among the six available IAMs that were able to assess the full range of climate scenarios we were interested in, we settled on the REMIND and MESSAGE-GLOBIOM (M-G) models as the foundations for our analysis. That is because they were more consistent with the observed take-up of different energy technologies over the past decade, as well as with our views of the most likely evolution of low-carbon technologies in the future. Each model's implications for energy-technology shares in the power sector between now and 2050 are illustrated in Figure 4.

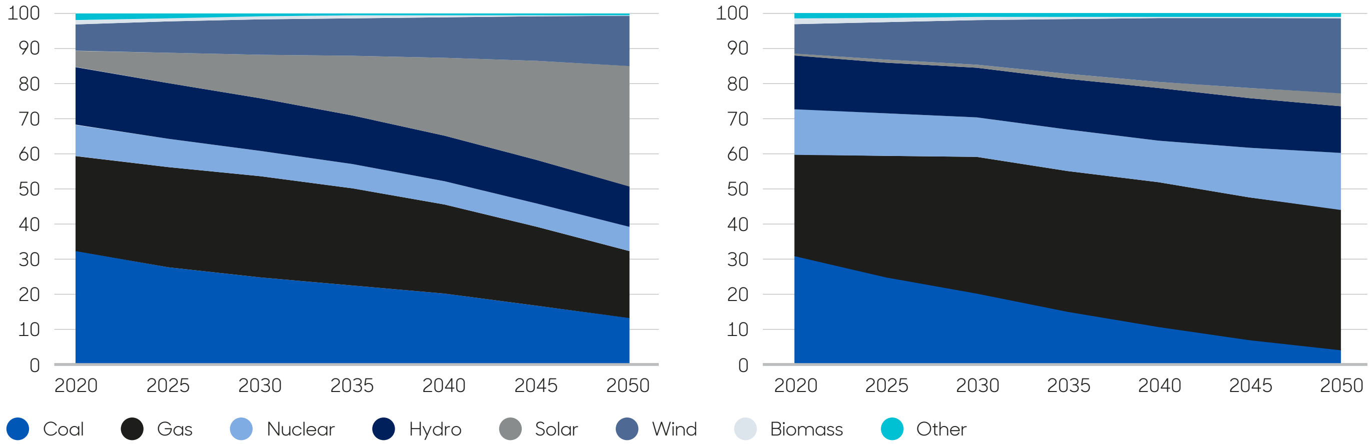
The REMIND model has three key features:

1. It is optimistic about the potential for the relative price of solar PV to continue its rapid decline. This permits the comparatively cheap decarbonisation of the global power sector without any significant negative effects on energy demand.
2. By allowing decarbonising of the power sector more quickly and cheaply, the need for natural gas to act as a transition fuel is reduced.
3. It is comparatively optimistic about the demand for oil, in part because faster decarbonisation of the power sector slows the speed of decarbonisation of the transportation sector.

Because the REMIND model was the only one to fully capture the potential for solar technologies to be the big winner in any energy transition, we make use of it in around half of our off-the-shelf and bespoke scenarios.

It is important to capture the potential for solar technologies to be the big winner in any energy transition. However, it would be dangerous to put all of our technology eggs in the solar basket.

Figure 4: Solar is the big winner in the REMIND model; natural gas in MESSAGE-GLOBIOM (%)



Electricity generation by share: REM_ADVANCE_Reference scenario (Current (renew.)) Data source: Planetrics and abrdn, January 2021.

Electricity generation by share: Baseline Scenario. Data source: Planetrics and abrdn, January 2021.

We therefore chose Message-Globiom (M-G) as our second 'base' model for analysis because it is more pessimistic about the future relative path for solar-PV prices and the ability to solve that technology's storage and transmission challenges. Instead, mitigation is driven more by higher carbon prices and the compression of energy demand.

This increases the importance of wind relative to solar within the renewable-energy mix and natural gas relative to renewables. Comparatively higher carbon prices also render CCS technologies more economically viable while increasing the contribution the transportation sector has to make to mitigation, reducing the demand for oil and increasing the market penetration of electric vehicles.

Because other IAM models implied either implausibly low renewable-energy shares in the future or unrealistically large roles for nuclear energy or coal, they were excluded at a relatively early stage. It is important to note that none of the models available to us are presently able to fully capture technologies like hydrogen energy that have not already been deployed at scale.

Policy pathways

When selecting our policy-choice set, we wanted it to be wide enough to allow for plausible and consequential differences, but also small enough for the analysis to remain tractable. We therefore decided on the following three parameter categories:

1. **Sectors** – Policy is allowed to vary across the four main market-relevant energy-use and carbon-emitting sectors: power, transportation, industry and buildings;

2. **Regions** – Policy is allowed to vary across five countries or regions – the US, the EU, the other developed economies as a group, China, and the other emerging economies as a group;

3. **Objectives** – Policy in each sector and region is allowed to have different mitigation objectives including the following:

   I. No climate mitigation policy at all – so a step back from the status quo in most countries;

   II. The maintenance of current policy settings;

   III. Policies set in line with nationally determined contributions (NDCs) to the Paris Agreement, which build on existing policies in most countries but fall short of what is necessary to limit climate change to below 2°;

   IV. Policies set in line with a 'weak' interpretation of the Paris Agreement – well below 2° with either a 50% or 67% probability – and including options for alignment with those objectives to begin in either 2020 or 2030;

   V. Policies set in line with a 'strong' interpretation of the Paris Agreement: 1.5° with alignment allowed to begin in either 2020 or 2030; and

   VI. An off-the-shelf scenario commissioned by PRI and developed by a research consortium led by Vivid Economics and Energy Transition Advisors called the Inevitable Policy Response, which was designed to create a more plausible pathway to Paris alignment than those captured by other off-the-shelf scenarios.

3.2 Our scenario choices and their key features

Table 2 shows the matrix of policy variations that combine to produce our 15 scenarios. The colour of the boxes represents different levels of policy ambition, with green denoting alignment with 1.5° objectives, yellow denoting alignment with 2° objectives, pink denoting objectives that go further than current policies but fall short of what is necessary to achieve Paris alignment, and red denoting no new policy commitment to mitigate emissions in those sectors or regions.

Off-the-shelf scenarios have identically coloured boxes because they do not allow for policy variation across geographies and sectors. Scenarios that err towards little mitigation tilt towards their physical impacts and have the largest effect on real assets like real estate and infrastructure. In scenarios that err towards strong mitigation, impacts are largely transitional, with impairment concentrated in fossil-fuel-intensive industries and businesses with few substitution possibilities.

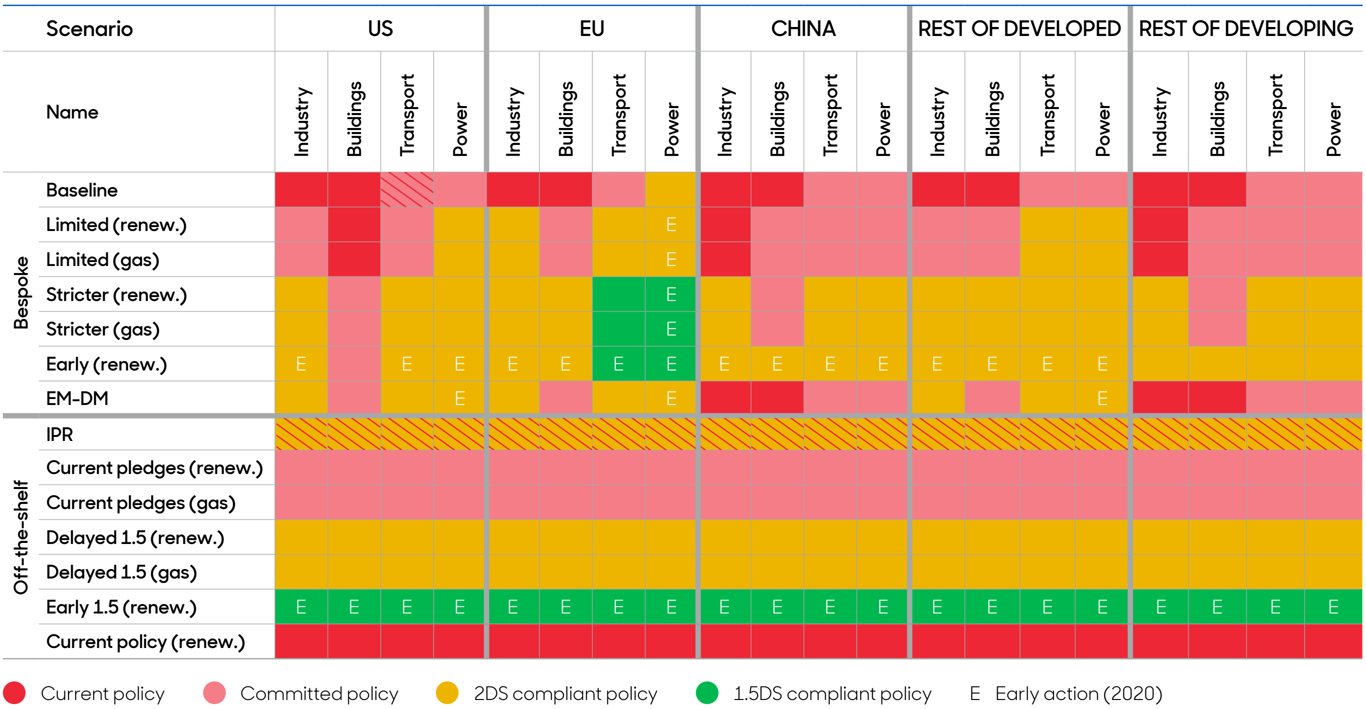
In the rest of this section, we set out in detail our rationale for our scenario choices.

The baseline scenario

The first important choice we had to make was how to design the baseline scenario, as all security impairment estimates are expressed relative to that baseline. As much as possible, this had to resemble what we think was being priced into the market in February 2020, the base date for this year's impairment calculations.

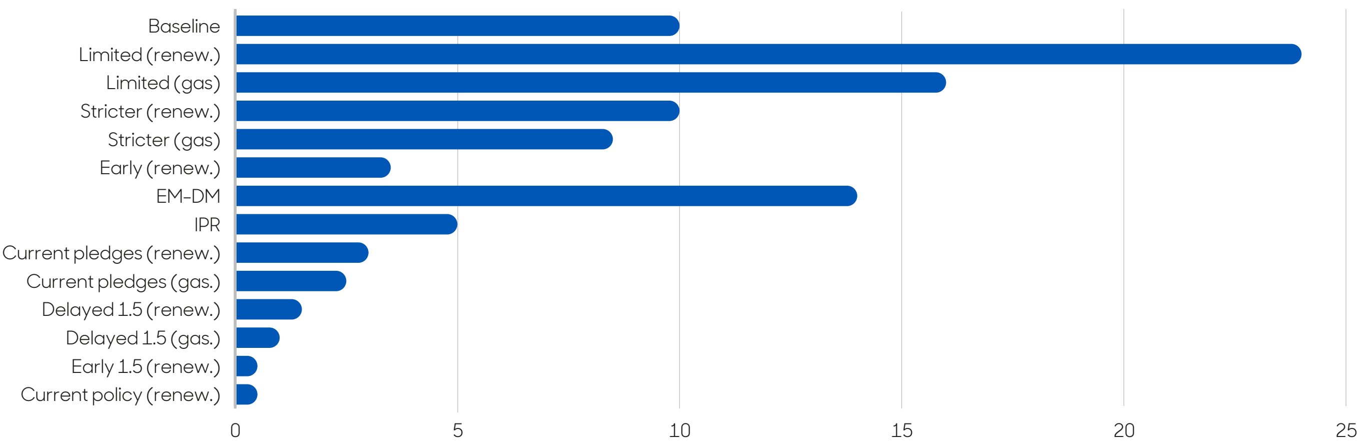
February was chosen as the starting point for this exercise because it allows us to abstract from the impact of the Covid-19 crisis on asset valuations. It also means that we

Table 2: Bespoke scenarios with modest additional policy ambition have the highest weights



Probability weights of each climate scenario

Scenario weightings (%)



Source: Planetrics.

avoid the internal consistency problems that would be created by benchmarking impairment estimates on the current market pricing of Covid-related economic and financial impacts while drawing on IAMs that have not been updated to reflect those same impacts. Our update scheduled for late next year will reconcile these tensions.

Our first assumption is that the market was placing relatively little weight on climate-policy changes due to occur beyond a 10-year horizon except under two conditions: 1) those policy changes were already clearly and credibly signalled; or 2) technology take-up and pricing trends were already pointing very strongly in a particular direction. The upshot is that we think markets were mostly pricing in only a moderate scaling up of existing policies in most sectors and regions.

That led us to conclude that for the **industrial and buildings sectors**, where there is little existing policy limiting emissions and where mitigation costs are very high, it was most sensible to conclude that the market was pricing in the maintenance of current policy.

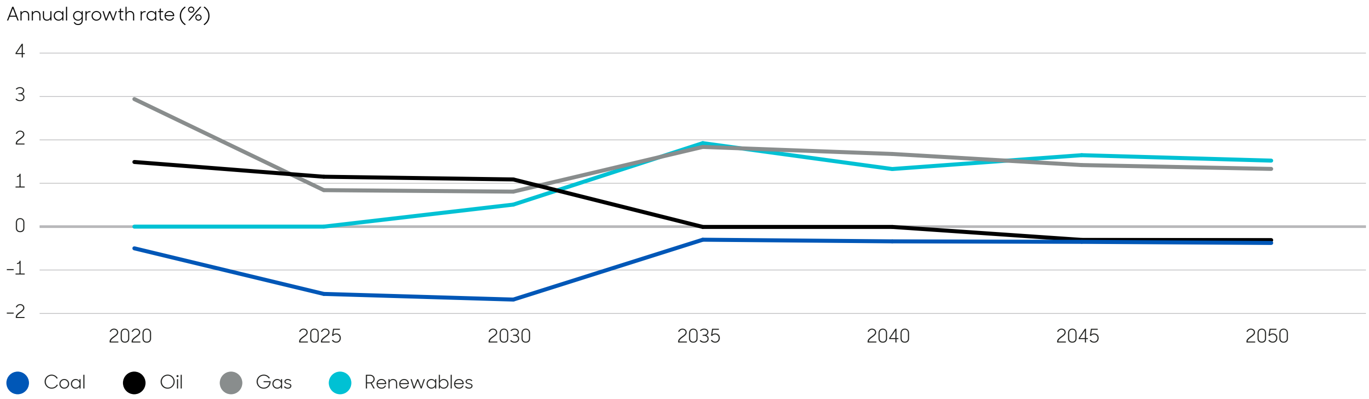
In contrast, **the power sector** was where the greatest reductions in carbon intensity had already occurred over the past decade, where emissions-trading schemes (ETS) and carbon taxes were already covering emissions in some countries, as well as legislated to be scaled up over time, and where low-carbon substitution was most feasible.

As a result, we have factored in the greatest policy change into the baseline for the power sector in all regions. Meanwhile, we are also assuming that the market was pricing in the largest amount of abatement in the European power sector, given the scope and legislative credibility of its ETS. Indeed, for Europe, our baseline assumes the market was pricing in Paris-aligned policies for the power sector, and the implementation of NDCs elsewhere.

The **transportation sector** was placed in the middle of these extremes. There are greater economic and policy barriers to electrification than in the power sector, but less than in the industrial and buildings sectors. Our oil analysts also considered that the market was pricing in a peak in global oil demand in the 2030s, an outcome compatible only with the increased policy stringency required to generate a solid rise in the market share of electric vehicles.

Similar logic was at play in our choice of energy-systems model. As explained earlier, the REMIND model is very optimistic about the future of solar technologies, even in scenarios with little policy ambition, but is pessimistic about the outlook for natural-gas demand. The relative pricing of utility companies with a heavy tilt towards renewables was not favourable enough at the time we 'froze' our starting point for market comparisons to make that our baseline model.

Figure 5: The evolution of energy demand in our baseline scenario



	2020	2050
Coal (Mtce/year)	5539	4394
Gas (billion m3/year)	4167	6171
Oil (Mbbl/d)	98.4	106.6
Solar (share %)	2	4
Wind (share %)	8	21

Global fuel production figures and renewable share (2020 & 2050) along with annual growth rate (Baseline scenario). Data source: Planetrics and abrdn, January 2021.

And despite large subsequent improvements in the relative price of renewable-tilted utilities from the second half of 2020, we still don't think that the REMIND baseline is being priced in by markets. Therefore, we have used the natural-gas-leaning M-G model as our baseline. We can, however, change the model baseline in the future as market expectations evolve.

The upshot is that our baseline scenario (which will be updated on an annual basis) currently maintains many of the trends that were in place in the years before the Covid crisis (see Figure 5).

These are among the most important trends:

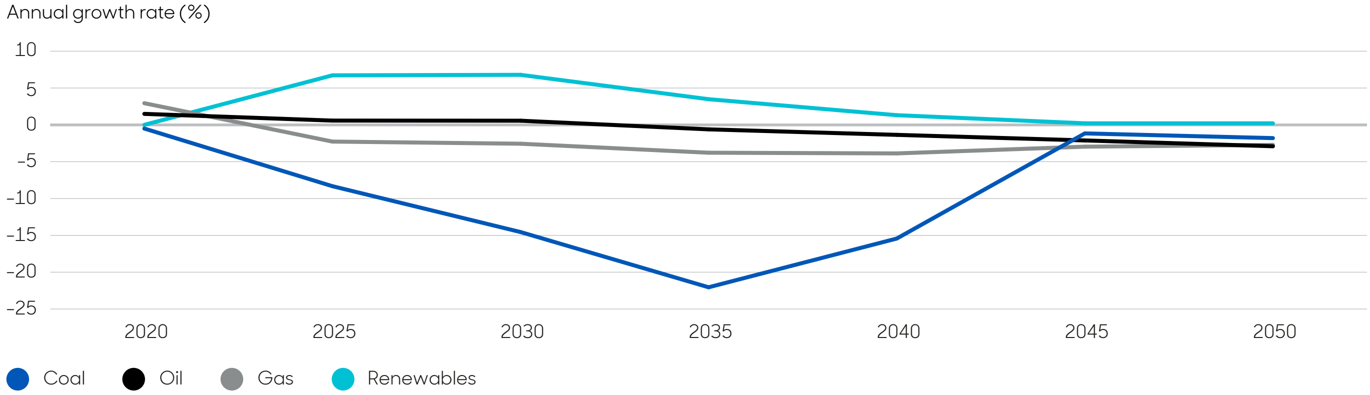
- Global coal demand declines at an average annualised rate (aar) of 0.7% over the next 30 years, compared to a 0.5% aar over the past five years;
- Oil demand peaks around the year 2030 and declines gently thereafter, with the share of electric vehicles rising from 3% of the light-vehicle market today to 62% by 2050;
- The use of natural gas increases at 1.5% aar, which, although more moderate than in the past five years, would cement its importance as a transition fuel;
- Renewable-energy demand continues to grow at a solid pace, with the combined global share of wind and solar energy in the power-sector mix rising from 10% in 2019 to 25% by 2050; and
- Despite the declining market share of fossil fuels and the slower pace of emissions growth, the objectives of the Paris Agreement are not met, with global temperatures increasing to 2.6° above pre-industrial levels by 2100.

When interpreting this baseline, it is important to keep in mind that extracting a consistent implied climate-policy and technology pathway from the market is very difficult. In addition, the baseline does not carry the highest weight in our probability-weighted analysis because our judgment is that policy is more likely than not to become more ambitious than what was priced into the market in February 2020. Finally, since February 2020, a number of countries have announced more ambitious carbon-emission-reduction targets that have led investors to reprice affected assets. We will take this into account in our 2021 update.

Off-the-shelf scenarios

As outlined earlier, off-the-shelf scenarios generally assume identical transitional objectives and policies across all sectors and geographies. We regard such assumptions as implausible against the backdrop of significant existing geographic and sector policy variations, and the likelihood that such variation continues. We have therefore assigned a very low combined-probability weight of 14% to the off-the-shelf scenarios in our analysis.

Figure 6: Energy usage under strict Paris alignment in the solar-friendly REMIND model



	2020	2050
Coal (Mtce/year)	5539	175
Gas (billion m3/year)	4167	1675
Oil (Mbbl/d)	98.4	73.2
Solar (share %)	2	56
Wind (share %)	8	22

Global fuel production figures and renewable share (2020 & 2050) along with annual growth rate (Early 1.5 (renew.) scenario). Data source: Planetrics and abrdn, January 2021.

However, the probabilities assigned to the off-the-shelf scenarios still vary. In an approach that we mimic in the bespoke assignment, scenarios implying either no change to climate policies from the status quo, or radical, rapid and broad-based change to the status quo, receive the lowest weights.

For example, the scenarios implying that policy evolves in line with countries' nationally determined contributions to the Paris Agreement but is not sufficient to achieve the objectives of that agreement receive a higher weight than scenarios aiming to limit temperature increases to 1.5° above pre-industrial levels. The off-the shelf scenario known as the Inevitable Policy Response (IPR) has the highest weight because its designers did allow for some geographic and sector variations.

A given off-the-shelf scenario assumes that policy is applied uniformly across all sectors and geographies, within a single energy-systems model. Policy sensitivity can therefore only be examined by altering assumptions for all sectors and geographies simultaneously. Nevertheless, we are able to account for alternative technology pathways by applying the REMIND and M-G models to the same off-the-shelf policy scenarios. This allows us to isolate the extent to which the estimated impairment on a given security is driven by the scenario's global policy assumption and its technology-pathway assumptions.

Although we place a low weight on the likelihood that global policy and technology pathways will allow temperature increases to be limited to 1.5° above pre-industrial levels, it is still useful to consider just how radical a shift in the global energy mix that would require.

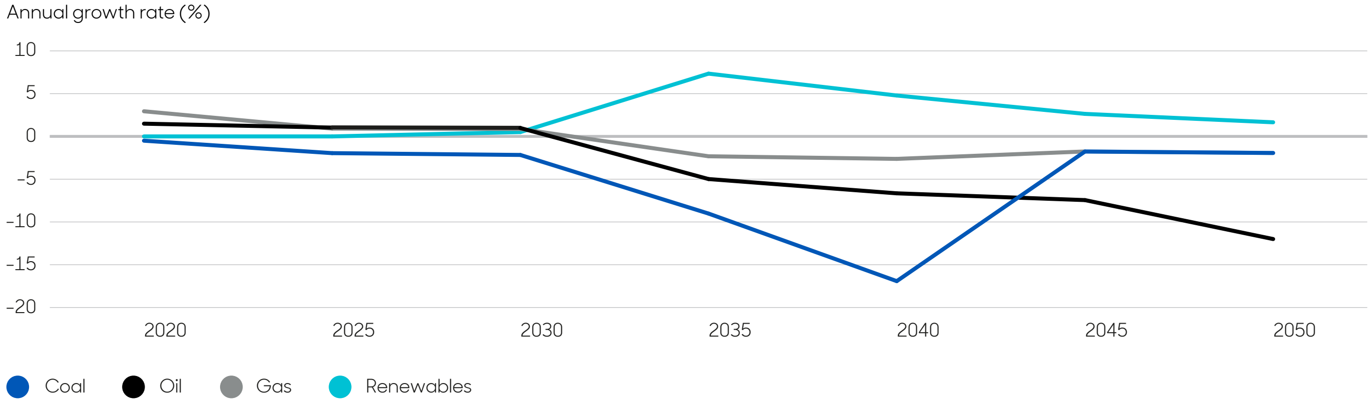
For example, in a scenario based on immediate action and drawing on the REMIND model (see Figure 6), the following would be required:

- The non-fossil-fuel share of energy in the power sector would need to increase to 97% by 2050, with wind power reaching 22% and solar 56%;
- Electrical vehicles would need to reach a market share of 89%, with oil demand declining at a 0.9% aar over the next 30 years;
- Coal and natural-gas usage would need to fall at a 10.8% and 2.8% aar respectively; and
- The weighted-average global carbon price (explicit or implicit) would need to reach \$181/tonne CO2 by 2035 in 2019 dollars and \$377/tonne by 2050.

If instead we use the scenario with the same temperature objective, but coordinated global policy action only begins in 2030 and we draw on the CCS friendly M-G model (see Figure 7), the following would be required:

- The non-fossil fuel share of energy in the power sector would need to increase to 89% by 2050, with wind power reaching 36% and solar 13%;

Figure 7: Energy usage under strict Paris alignment in the gas-friendly M-G model



	2020	2050
Coal (Mtce/year)	5539	921
Gas (billion m3/year)	4167	2943
Oil (Mbbl/d)	98.4	21.4
Solar (share %)	2	13
Wind (share %)	8	36

Global fuel production figures and renewable share (2020 & 2050) along with annual growth rate (Delayed 1.5° (gas) scenario). Data source: Planetrics and abrdn, January 2021.

- Electrical vehicles would need to reach a market share of 100%, with oil demand declining at a 5% aar over the next 30 years;
- Coal and natural-gas usage would need to fall at aars of 5.7% and 1%, respectively; and
- The weighted-average global carbon price would need to reach $438/tonne CO2 by 2035 in 2019 dollars and $885/tonne by 2050.

As intimated earlier, the main purpose of the off-the-shelf scenarios is to allow us to benchmark our results with those of our competitors, industry bodies and the expectations of regulators. We regard our bespoke-dominated approach as analytically superior but including both allows for more transparent comparisons.

Bespoke scenarios

Like our baseline scenario, most of our bespoke scenarios are also predicated on the view that there is a stronger, more credible and more sustained commitment to significant climate-change mitigation in Europe than in most other developed markets. We are also of the view that most emerging economies – including China – will lag behind the developed world because political economy considerations are more likely to favour near-term growth over long-term environmental considerations.

The impact of these relative policy judgements can be seen in the colour coding of Table 2. In every bespoke scenario, policy tilts towards greater abatement in Europe than elsewhere, and towards greater abatement in developed-market economies than emerging-market economies as a whole. The exceptions are the 'Paris-aligned' bespoke scenarios because they cannot be achieved without very large emissions reductions also occurring in the emerging world and thus a convergence of global policy across geographies and sectors.

Focusing on sectors, we also maintain the view underpinning the baseline scenario that policy action and low-carbon technological changes related to the power sector are likely to be stronger than those in the transportation sector, which in turn are likely to be stronger than those in the industrial and buildings sectors. Technology transfer across borders is more likely in the transportation sector than in the industrial and building sectors thanks to the greater supply-chain and market integration.

Technological barriers to lowering industrial emissions are more diffuse, while the greater potential for carbon leakage presents a larger politico-economic barrier to stronger action. Meanwhile, the extended life cycle of buildings is a major barrier to progress without an extensive and expensive retrofitting regime in place.

As explained earlier, models that are more optimistic about the potential for the costs of solar-energy production, storage and transmission in the power sector to fall (REMIND) will generate stronger growth in the use of solar energy and weaker growth in the use of wind and natural gas, compared with models that are more pessimistic about solar technology (M-G).

However, because we do not want our analysis to be dependent on any one model's assumptions about technology given the uncertainties, the REMIND and M-G-model-based scenarios have roughly equal combined weights in our analysis. Nevertheless, when the baseline model is excluded, the probabilities are modestly tilted towards the more renewable-friendly REMIND model. That tilt relates to the observed technological changes over the past decade and our reading of the evidence related to future developments. These imply that the relative cost of solar PV is likely to continue to decline and that there will be greater potential to solve the storage and transmission problems that constrain its market share. In contrast, the potential for large-scale CCS deployment is less certain.

Calculating our probability-weighted mean scenario

In total, we have 14 bespoke and off-the-shelf scenarios to which we are assigning at least some weight. The baseline scenario is an approximation of what we think is currently priced into assets, but it is not our modal scenario. Against the baseline's 10% initial probability, there are three other scenarios to which we assign more weight: limited-action renewables (24%); limited-action gas (16%) and developed-market-emerging-market (DM-EM) divergence (14%). The key features of all the scenarios are summarised in Table 3.

Table 3: Descriptive characteristics of our climate scenarios

	Scenario	Alternative scenario name	Description	Region and sector action pathways	Model	Temperature change* 2050	Temperature change* 2100	Probability weighting
	Baseline	Baseline	Baseline of existing market assumptions	Eur > DM = USA = China = EM Power > Trans. > Ind. = Build.	MESSAGE-GLOBIOM	1.8	2.6	10.0%
Bespoke	Limited action renewables	Limited (renew.)	Limited new policy action; renewables tilt	Eur > DM > USA > China = EM Power > Trans. > Build. > Ind.	REMIND	1.9	3.2	24.0%
Bespoke	Limited action gas	Limited (gas)	Limited new policy action; gas tilt	Eur > DM > USA > China = EM Power > Trans. > Build. > Ind.	MESSAGE-GLOBIOM	1.8	2.4	16.0%
Bespoke	EM-DM divergence	EM-DM	Larger DM-EM policy divergence	Eur = DM = USA > China > EM Power > Trans. > Ind. > Build.	MESSAGE-GLOBIOM	1.8	2.4	14.0%
Bespoke	Stricter action renewables	Stricter (renew.)	Stricter but delayed new policy action; renewables tilt	Eur > DM > USA > China = EM Power > Trans. > Ind. > Build.	REMIND	1.8	1.9	10.0%
Bespoke	Stricter action gas	Stricter (gas)	Stricter but delayed new policy action; gas tilt	Eur > DM > USA > China = EM Power > Trans. > Ind. > Build.	MESSAGE-GLOBIOM	1.8	1.9	8.5%
Bespoke	Early action renewables	Early (renew.)	Stricter immediate policy action; renewables tilt	Eur > DM > USA > China > EM Power > Trans. > Ind. > Build.	REMIND	1.7	1.7	3.5%
Off-the-shelf	IPR (Forecast Policy Scenario)	IPR	Inevitable Policy Response**			1.9	N/A	5.0%
Off-the-shelf	INDC (REMIND)	Current pledges (renew.)	Current Paris Agreement commitments; renewables tilt		REMIND	2.2	3.4	3.0%
Off-the-shelf	INDC (M-G)	Current pledges (gas)	Current Paris Agreement commitments; gas tilt		MESSAGE-GLOBIOM	1.9	2.5	2.5%
Off-the-shelf	2030 Price 1.5 DS (REMIND)	Delayed 1.5 (renew.)	Delayed Paris alignment; renewables tilt		REMIND	1.9	1.6	1.5%
Off-the-shelf	2030 Price 1.5 DS (M-G)	Delayed 1.5 (gas)	Delayed Paris alignment; gas tilt		MESSAGE-GLOBIOM	1.8	1.5	1.0%
Off-the-shelf	2020 1.5 DS (REMIND)	Early 1.5 (renew.)	Immediate Paris alignment; renewables tilt		REMIND	1.7	1.4	0.5%
Off-the-shelf	Current policy (REMIND)	Current policy (renew.)	Current policy action; renewables tilt		REMIND	2.3	4.1	0.5%
	Probability weighted mean#	PWM			N/A	1.8	2.5	N/A
	Paris Alignment (probability weighted mean)##				N/A	1.8	1.8	N/A

* Projected global average temperature rise relative to pre-industrial levels
** https://www.vivideconomics.com/the-inevitable-policy-response/
# PWM figures based on assigned weights across scenarios
Paris Aligned figures are calculated from the scenarios with a 2100 temperature change below 2 degrees, using the same weightings applied to the PWM
Source: Planetrics and abrdn calculations, January 2021.

"Technology transfer across borders is more likely in the transportation sector than in the industrial and building sectors thanks to the greater supply-chain and market integration."

By multiplying the probability weights assigned to each scenario by their respective energy-usage patterns, carbon prices and temperature changes, we can generate probability-weighted summaries of the inputs that will underpin the estimates for financial-security impairments that we will share in the next chapter. However, it is worth summarising how these probability-weighted outcomes differ from both the baseline and the strict Paris-aligned scenarios outlined earlier (see Table 4). The following are of particular note:

- Global coal demand declines at an average annualised rate (aar) of 0.9% over the next 30 years. That is more than in the baseline scenario but much less than in the 1.5° scenarios;
- Oil demand declines at a 0.1% aar, with the share of electric vehicles in new sales rising to 66% by 2050. That is again more than in the baseline scenario but much less than in the 1.5° scenario;
- The use of natural gas increases at 1.1% aar, less than in the baseline because of weight given to the renewable-friendly REMIND model. This offers a reminder that natural gas's role as a transition (or bridge) fuel is anything but certain and that natural gas's future role in the energy system depends not only on the cost of gas or CCS, but also on competing technologies;
- The non-fossil-fuel share of energy use in the power sector reaches 73% by 2050, roughly halfway between the baseline and 1.5° scenarios;
- That result underscores the critical point that the power sector is likely to be the epicentre of an enormous energy transition even if global policy does not align behind the objectives of the Paris Agreement;
- Indeed, we are already seeing this in the major advanced economies, where over the last decade almost all new power generation that has been built, is under construction, is contracted or is under development is either variable renewables or natural gas;

Table 4: Comparative energy-technology growth rates in our mean and Paris-aligned scenarios

Average annual growth rate (2020-2050) %	Coal	Gas	Oil	Solar	Wind
Baseline	-0.68	1.52	0.29	2.34	3.27
Probability-weighted mean	-0.88	1.08	-0.09	8.93	3.43
Paris-aligned mean	-4.43	0.28	-0.6	10.11	4.01
Early 1.5 (renew.)	-10.79	-2.84	-0.98	11.72	3.43
Delayed 1.5 (gas)	-5.72	-0.96	-5.01	6.44	5.14

Source: Planetrics and abrdn, January 2021.

- It also highlights the ways our bespoke, probabilistic approach generates insights into the future of energy-demand patterns that differ from what we could obtain from anchoring on a narrow set of policy and technology pathways; and
- Although global average carbon prices are higher in the probability-weighted scenario than in the baseline, the world still falls well short of limiting temperature increases to less than 2°, with the model average implying a 2.4° increase.

3.3 Paris alignment: a plausible but not probable outcome

As outlined in the previous section, the scenarios carrying the most weight in our analysis are not consistent with the world meeting the objectives set out in the Paris Climate Agreement, though they do imply greater policy change than implied by both the status quo and our baseline.

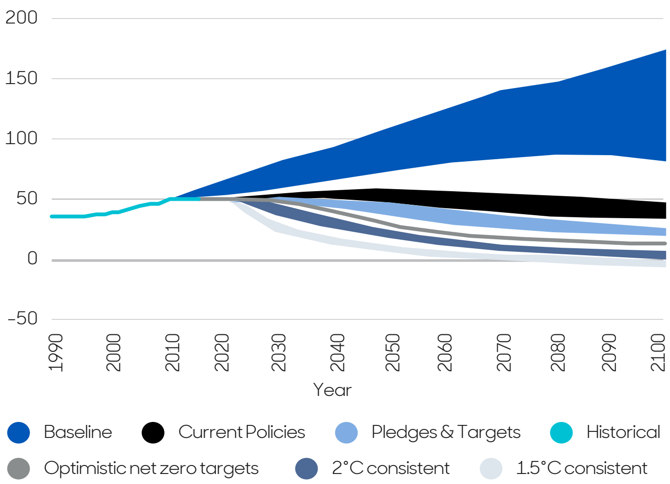
Why do we not think that meeting the Paris Agreement objectives is probable? Limiting climate change to 1.5° above pre-industrial levels would require global emissions to fall by almost 8% per annum on average until net-zero emissions are reached – and that figure rises for every year in which policy change is delayed relative to what is necessary.

Net-zero-2050 objectives require unprecedentedly rapid and broad-based decarbonisation

On current emissions trends, for example, the world will have used up its entire carbon budget for a 1.5° world within a decade, at which point emissions would have to fall to net zero immediately to avoid overshooting the 1.5° objective, or eventually give way to a long period of large negative emissions (see Figure 8).

Figure 8: Implied 'Paris-aligned' emissions pathways

Global greenhouse gas emissions $GtCO_2e$/year



Projected global emissions to 2100. Source: Climate Action Tracker. Jan 2021.

Even achieving a 2° target requires global emission reductions equivalent to around 3% per annum, which will be very difficult without a significant global acceleration in the decarbonisation of the power sector, an electrification of all other sectors and the coordinated policy action to match.

Although the growth of global emissions slowed in the five years before the Covid crisis, they were still on a modest rising trend, with only a very small number of countries reducing their emissions on the scale required by the Paris Agreement. And while the Covid crisis led to a dramatic decline of global emissions between January and May, emissions have rebounded subsequently, albeit not yet to their pre-Covid level.

More importantly, that short period of declining emissions was mostly attributable to the pandemic-related collapse in economic activity rather than any durable de-carbonisation of the global economy. Emissions began rising again as soon as the recovery began and are now close to their pre-pandemic levels in key countries like China.

We do expect the crisis to lower the trajectory of emissions relative to its pre-Covid trend in line with the long-term economic damage and structural changes in demand we are factoring in. But those effects are small relative to the scale of the absolute emissions declines that are necessary. This is particularly the case in emerging economies, where most of the growth in emissions has taken place over the past two decades (see Figure 9) and future growth will also be greatest, though of course the advanced economies accounted for the majority of emissions in the previous century.

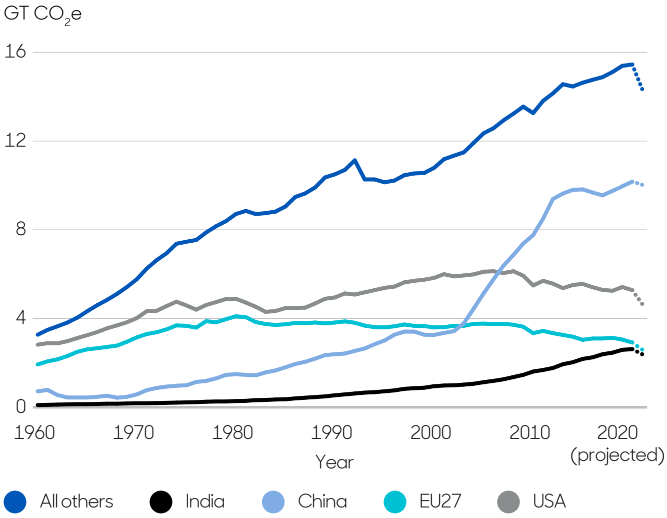
It is worth noting that stabilising global temperatures at any level requires global emissions to eventually reach net zero, while scenarios that involve first overshooting Paris objectives and then lowering temperatures further into the future require persistent negative emissions. What alters with any temperature-stabilisation outcome is the speed of decarbonisation and the date at which net-zero emissions are reached.

Action finally scaling up in China and the US, but with important gaps

Of the world's largest-emitting regions and countries – China, the US, the EU and India – only the EU has a legally binding national emissions cap via its ETS. Moreover, even Europe's ETS covers only 50% of its production emissions, excluding residential natural-gas consumption for heating and cooling while ignoring the consumption emissions derived from its imports of carbon-intensive consumer and capital goods. The upshot is that its carbon footprint is larger than it appears.

China recently surprised the world with its announcement of a 2060 net-zero emissions target. But at this point, that target is not backed up by fully detailed and credible

Figure 9: Emerging economies accounted for most of the increase in emissions since the year 2000



Historic regional CO2 emissions 1960-2020. Source: Global Carbon Project. Jan 2021.

policy plans. For example, China is on the precipice of launching a national ETS, following experimentation with regional pilot schemes since 2011. This will help to improve the carbon efficiency of its large coal-fired power fleet in particular. But its sector coverage will be narrow, at least initially, encompassing mainly coal- and gas-fired power plants. And its implied carbon-price trajectory is low, in part because the emissions allowances will not be very stringent, especially for larger facilities.

China also increased its investment in coal-fired power stations in 2020 while pursuing an industrially focused economic recovery plan. And even taking China's targets at face value implies that emissions would not peak until 2030, leaving all the necessary global emissions reductions over the next decade to other countries.

Under President Trump, the US undermined international efforts to limit climate change by pulling out of the Paris Agreement while simultaneously unwinding Obama-era climate regulations, though aggregate emissions did continue to fall thanks in part to stronger regional action being taken, particularly in the Northeastern and Pacific Coast states.

The election of Joe Biden to the presidency and the Democrats' narrow majorities in the House and Senate herald a more constructive approach to climate mitigation. This will allow the US to re-join the Paris Agreement, increase federal spending on green infrastructure and impose more restrictions on emissions through tighter regulation.

Nevertheless, we have to temper our expectations for how much can be achieved under unified Democratic government. While the filibuster remains in place, Republicans opposed to more stringent action will still be able to block any new legislation that does not fit within budget-reconciliation rules. New regulations imposed by the Environmental Protection Agency are likely to be challenged in the now more conservative Supreme Court. And, most importantly, meeting the objectives of the Paris Agreement requires consistent efforts over very long time horizons. As long as the importance of addressing climate change remains subject to partisan disagreement, periods of reversal are likely during periods in which Republicans hold the reins of power.

A modest overshooting of the Paris goals is the most likely outcome

As stated in the previous section, the probability-weighted mean implies a rise in global temperatures of close to 2.5° by the end of the century, with the bulk of our probability mass lying between 2 and 3°. We assign a 30% probability to emissions being reduced enough to limit temperature increase to below 2° (a weakly Paris-aligned outcome), though only 3% to a 1.5° outcome (strong Paris alignment).

Scenarios consistent with temperature increases above 3° are currently collectively assigned a probability of 27.5%, though again we assign a very low probability to larger extremes, which in this case are the maintenance of the current policy status quo or no mitigating policy at all. We also think it is more likely that policy in the developed world will align around emissions reductions consistent with the Paris objectives than is the case for the emerging world as a whole, which explains why EM-DM divergence is our third-most-likely scenario after our two limited-policy-action scenarios.

More detail on how we assess current climate policies, their credibility and the political economy driving future policy change for the major emitters can be found in our 'Going Green' white paper and its country and regional case studies.

Although we do not expect global policy to scale up by enough to limit climate change to 2° or less, we think that the 30% collective probability we have assigned to Paris-aligned scenarios is sufficiently high for investors to take seriously in their asset allocation, especially given the large changes in the energy mix that would be associated with more aggressive climate action.

If Paris alignment did take place, the energy transition would accelerate

Our approach also allows us to think probabilistically about Paris alignment and its consequences for asset prices. For example, if we apply probability weights to just the Paris-aligned scenarios and then compare the energy-mix projections with the probability-weighted mean across all 14 scenarios, as well as one of the off-the-shelf 1.5° scenarios common in other analyses, the differences are striking (see Table 4) – the following in particular:

- Global coal demand declines at an average annualised rate (aar) of 4.4% over the next 30 years. That is less than in the 1.5° scenarios but more than in the probability-weighted scenario, underpinning the grim future for coal in a Paris-aligned world;
- Oil demand declines at a 0.6% aar, with the share of electric vehicles in new sales rising to 80% by 2050. That again highlights how difficult a Paris-aligned future would be for oil companies and auto companies dependent on producing internal-combustion-engine vehicles;
- The demand for natural gas increases at just a 0.3% aar, around a tenth of the pace of the past five years and a third of the pace in our current probability-weighted scenario. Demand growth is even weaker in strong-action scenarios that draw on the REMIND model; and
- The non-fossil fuel share of energy use in the power sector reaches 88% by 2050, with solar and wind alone taking half of the market.

Taking a probability-weighted approach can also be useful for companies and investors considering a more nuanced approach to Paris alignment. We discuss this in much more detail later in the paper. Meanwhile, by integrating a rich and diverse set of Paris-aligned scenarios into our broader approach, we can more easily update our framework in the face of changes to the underlying political, policy, economic and technology drivers of the scenarios.

3.4 The triggers for revising scenarios and their probability weights over time

The choice, design and assignment of probabilities to the scenarios have been made on the basis of our best current evidence-based judgement about the political economy of global climate policy, and feasible technological pathways. As with any scenario-analysis framework, however, scenario design and probability assignments must be revisable against transparent criteria as new information comes to light.

We propose to revise the scenario design and probabilities on an annual basis at the same time as we refresh the scenario analysis itself each year. However, more timely changes will be made if we think there has been a sufficiently significant and durable change in the underlying drivers.

The waymarks for changes to our scenario construction and associated probability weights fall into the following four categories:

- Concrete, credible, durable and significant climate-mitigation-related policy or regulatory changes at the sub-national, national and international level.
- Changes in political leadership and public attitudes that are likely to translate into the changes denoted in the first criterion.
- Sustained behavioural changes among consumers, corporations and investors that are likely to significantly alter climate-relevant patterns of energy demand and supply.
- Revealed changes in aggregate, regional and sectoral investment decisions or low-carbon technological progress that alter the economics and timescales for abatement.

In each case, it is only significant changes relative to what we have already factored into our scenario construction and existing probability assignment that will prompt revisions. Information relevant to decisions will be derived from internal research, including the views of investment teams, and research from a wide range of external providers and sources.

Examples under each category might include the following:

- The introduction (elimination) of or scaling up (down) of an ambitious ETS or carbon price in a country or region whose emissions have a significant impact on the potential to meet global climate objectives;
- The election of a government with a greater (lesser) commitment to mitigating climate change, together with a credible policy agenda supporting implementation.
- A significant increase (decrease) in the emissions-weighted proportion of listed and non-listed companies scaling up (down) their individual emissions-reduction targets.
- A significant increase (decrease) in the growth rate of electric-vehicle penetration in the light-vehicle market, or a decrease (increase) in the installation of coal-fired power plants in emerging economies, or a decline (rise) in the expected relative installation and storage costs of intermittent renewable-energy sources.

When considering the above, there are some important caveats. Increases in emission reduction or other climate-related targets that are not accompanied by binding, credible supporting mechanisms will be lowly weighted when considering changes.

Similarly, when new governments with climate policies that differ significantly from the previous government are elected, the stability of those governments and the breadth of support for their climate ambitions will influence the extent of probability changes.

Finally, in circumstances in which corporate commitments are being increased, we will consider the extent to which there is likely to be emissions leakage to other entities (like state-owned enterprises) not otherwise considered in our scenario analysis.

"By integrating a diverse set of Paris-aligned scenarios, we can update our framework in the face of political, policy, economic and technological change."

Part 4: Climate scenario results: dispersion is king

Armed with our 14 individual climate scenarios, the probability-weighted means and the implications each has for different patterns of energy demand and usage, we can now explore their estimated financial impacts. Most of the analysis that follows focuses on simulated effects on the fair value of equity securities in the MSCI World Index, because that is the asset class for which the estimated effects are greatest. However, we also show the impacts on listed credit securities for comparison.

Note that in the analysis that follows, all references to the valuations of individual companies relate to stylised climate scenarios rather than a specific, concrete state of the world as it pertains to all of the factors that might affect the future revenue, earnings and realised value of the company. As such, impairment estimates should not be regarded as either forecasts or projections, and do not represent investment recommendations of any kind.

The results are sketched out in a hierarchy, beginning with index-level effects, then sectors, sub-sectors and regions, before ending with security-level impairment estimates. It is at this last, most disaggregated level that most of the dispersion of climate risks and opportunities is to be found. All impacts are expressed as a percentage deviation in fair value compared with the baseline scenario (Figure 10).

At the highest level of aggregation – the MSCI World index – the impairment and uplift differences between scenarios is relatively small, even between the tail scenarios with the strongest climate-mitigation action and the largest changes in the energy mix compared with the baseline. That is because the large negative effects on many individual securities are mostly offset by positive effects on others.

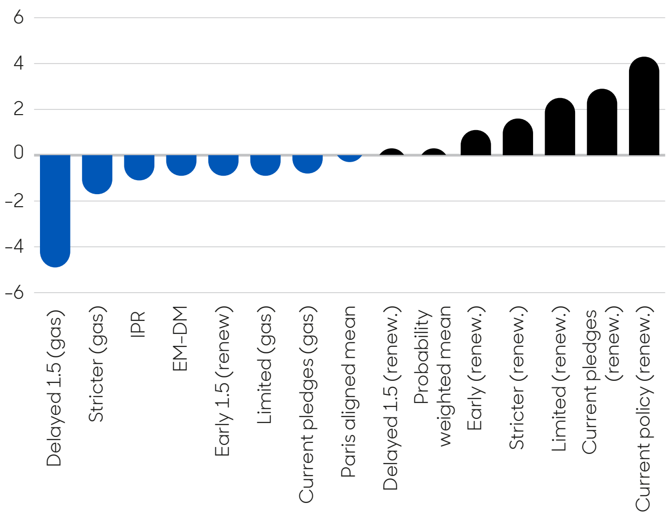
Critically, the strong-policy-action scenarios associated with rapid declines in the relative price of renewable technologies are positive for equities in aggregate because they involve lower carbon prices and higher demand for variable renewables and green minerals than in the baseline.

This is a very important result as it implies that, from an aggregate financial perspective, there is little need for diversified investors to fear the energy transition, at least over the long run, as long as they avoid firms that cannot or choose not to adapt their business strategies appropriately. Of course, over shorter horizons, investors still need to tread carefully because the energy transition, the market pricing of that energy transition and asset owners' willingness to hold carbon-intensive assets, may not proceed in a smooth, linear fashion. Indeed, it is instructive that the scenario that is worse for aggregate equities involves strong but delayed and therefore more disruptive policy action.

Other important takeaways include the following:

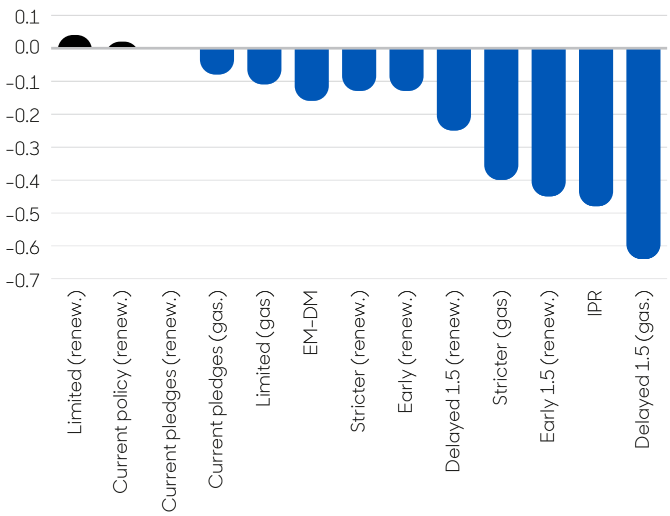
- Our probability-weighted mean scenario generates only a miniscule impact across the whole asset universe;
- The larger negative effects of our more ambitious climate-transition scenarios derive from larger amounts of demand destruction and higher carbon costs for fossil-fuel-intensive sectors and firms;
- REMIND-based scenarios generate substantial increases in demand for renewable technologies and the renewable supply chain, like green minerals, resulting in small net-positive index impacts; and

Figure 10: At the MSCI World index level, impairments are generally modest (%)



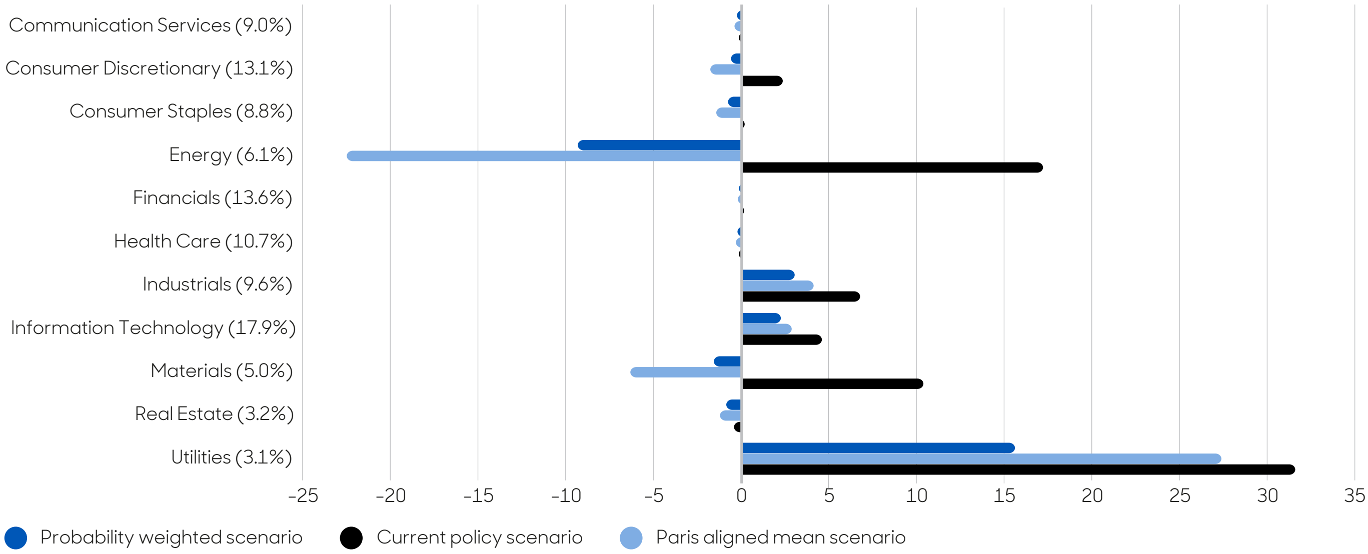
MSCI World Index-level total impact across all scenarios (mean-weighted by market cap, relative to what is priced into the baseline). Data source: Planetrics and abrdn analytics., January 2021.

Figure 11: Aggregate impacts on credit indices are smaller than for equities (%)



They will be added to our Year 2 programme. Change in average 10y cumulative survival probability. Probability-weighted mean and Paris Aligned scenarios were not able to be calculated in our Year 1 programme. Data source: Planetrics and abrdn analytics, January 2021.

Figure 12: Impairment is concentrated in a small number of sectors (%)



Comparison of sector-level impact or impairment (means-weighted by market cap, relative to what is priced into the baseline) under three scenarios. Bracketed percentage shows the sector weight within the aggregate index. Data source: Planetrics and abrdn analytics, January 2021.

- A continuation of current policy generates the most positive aggregate effects because existing firms do not face higher costs or weaker demand, and the current composition of indices does not capture the upside of smaller green companies that might grow into the index.

However, this scenario is obviously associated with the largest physical climate impacts and risk. The financial impacts of this physical risk are modest out to 2050 – the end of our modelling period – but would be much larger in the second half of the century.

Because impairment estimates are driven by projected changes in earnings, there is naturally a high correlation between the effects on equity and credit indices. However, the shorter time horizon for debt instruments and the fact that debt is higher up the capital structure than equity result in smaller index-level impacts across scenarios (Figure 11).

The generally small index-level impacts might lead some readers to conclude that climate risk is not very material. However, these 'world-level' results hide large amounts of variation between sectors, sub-sectors and the firms within those sectors. This is largely driven by differing company-level exposures to demand changes and carbon costs. This dispersion is critical for identifying where risks and opportunities lie. We explore these granular implications in more detail in the rest of the chapter.

4.1 The impact of the energy transition is concentrated in a small number of sectors

Once we drill down to the next level of aggregation – the 11 MSCI sectors – variation in exposure to the different climate scenarios becomes more evident. In what follows, we focus on the impacts of three scenarios: the probability-weighted 'mean' scenario, which captures the central tendency of our climate-risk distribution; the Paris-aligned probability-weighted scenario, which captures the mean across the six scenarios that are consistent with the objectives of the Paris Agreement and imply the largest and fastest energy transitions; and the current policy scenario, which implies only modest changes in the energy mix and, importantly, less than in our baseline scenario.

Beginning with the probability-weighted mean scenario (hereafter, the mean scenario), Figure 12 shows that the negative sector-level effects are concentrated in the energy sector and positive effects are concentrated in the utility sector. Other sectors are more or less unaffected in aggregate.

For the most part, the sector-level effects of the Paris-aligned mean scenario (hereafter, the Paris-aligned scenario) are an amplified version of the mean scenario, with the negative net impairment in the energy sector larger and the positive net impairment in the utility sector also larger.

Under current policy, impacts for those sectors that are negatively affected under stronger climate-policy-action scenarios are generally flipped, with the energy sector now highly positively affected and the materials sector also showing uplift. However, the utilities, industrials and information technology sectors are also positively affected in the current policy scenario, meaning that they experience aggregate uplifts in all three types of scenario. We return to this later.

For these patterns of sector dispersion across scenarios, the intuition is mostly straightforward. The energy sector is currently highly fossil-fuel-intensive. Therefore, in any scenario associated with a significant rotation in energy demand away from fossil fuels and towards renewables (demand destruction) or meaningful increases in carbon costs, the majority of firms in the sector will be negatively impaired. This is because they are, on average, unable to make up for the resultant drag on earnings by passing on their higher costs to end-users (see Table 5). The reverse is naturally true under current policy because there are no carbon costs and there is demand creation relative to the baseline.

The relative drivers of the negative effects of the mean and Paris-aligned scenarios on the materials sector are different from those on the energy sector. For materials, direct carbon costs account for more or less all of the drag on performance as there is more or less no net demand destruction. Meanwhile, most of the negative effect on the sector from higher carbon costs are offset by firms' ability to pass those costs on, as well as by their meaningful abatement options and the demand creation arising from the additional material needs of electrical vehicles, for example.

The modest positive results for the information and technology sector under the mean and Paris-aligned scenarios are also intuitive. Direct carbon costs are relatively low because, in the aggregate, the sector is not very energy-intensive. Moreover, those costs are more than offset by the sector's abatement options, ability to pass higher costs through, and, most of all, the demand created through the energy transition.

The net effects of the move away from fossil fuels on the utility sector, on the other hand, need more explanation. At first glance, it seems odd that a sector that, globally, is still highly dependent on fossil fuels to generate power is the most positively affected in scenarios in which the energy mix moves away fossil fuels and where carbon pricing is already most prevalent. And, indeed, direct carbon costs are higher than for any other sector in both the mean and Paris-aligned scenarios.

However, unlike the energy sector, the electrification of the transportation and other major energy usage sectors, leads to significant demand creation. And the utility sector also has a much greater ability to pass higher carbon costs on to end-users – especially renewable operators, who benefit from the price uplift derived from carbon pricing but without facing any of the costs.

But why, then, does the utilities sector also experience net benefits in the current policy scenario? Under current policy, there are no carbon costs that have to be absorbed into margins. And though renewable-focused utilities do not benefit from as much demand creation or higher margins from cost pass-through as under stringent-action scenarios, fossil-fuel-focused utilities benefit from lower carbon costs relative to the baseline while renewable-focused utilities benefit from the fact that the current policy scenario draws on the renewable-friendly REMIND model.

A little later on, we will look further at how the dispersion of impacts on different types of utility firm changes under our various scenarios. The upshot is that the utilities sector does not experience negative net impairment under any of our scenarios (see Figure 13).

4.2 Impairment within the aggregate sectors is highly dispersed

In the previous section, we showed how sector dispersion under our different climate scenarios was greater than at the aggregate index level. In this section, we drill down further into those sector results to show that the dispersion

Table 5: Breakdown of impact drivers for each sector under the mean scenario (%)

	Physical impact	Adaptation	Demand destruction	Demand creation	Direct carbon costs	Abatement	Cost pass-through	Total impact
Communication Services	-0.6	0.2	0.0	0.0	-0.7	0.6	0.2	-0.3
Consumer Discretionary	-1.2	0.4	-1.1	1.2	-3.1	2.1	1.1	-0.6
Consumer Staples	-1.3	0.5	0.0	0.2	-4.2	2.4	1.7	-0.7
Energy	-3.0	1.2	-7.9	0.3	-10.8	1.6	9.3	-9.3
Financials	-0.4	0.1	0.0	0.1	-0.4	0.1	0.3	-0.2
Health Care	-0.8	0.3	0.0	0.1	-1.9	1.2	1.0	-0.2
Industrials	-1.4	0.5	-0.3	4.2	-5.6	1.9	3.8	3.1
Information Technology	-0.6	0.2	0.0	2.7	-1.9	1.2	0.7	2.3
Materials	-2.5	0.9	-0.2	3.1	-21.1	6.8	11.5	-1.5
Real Estate	-3.3	1.3	0.0	0.1	-1.3	1.0	1.4	-0.8
Utilities	-3.0	1.1	-1.0	11.8	-35.7	3.3	39.2	15.6

Sector-level impact drivers and total impact (means-weighted by market cap) under the probability-weighted mean scenario. Data source: Planetrics and abrdn analytics, January 2021.

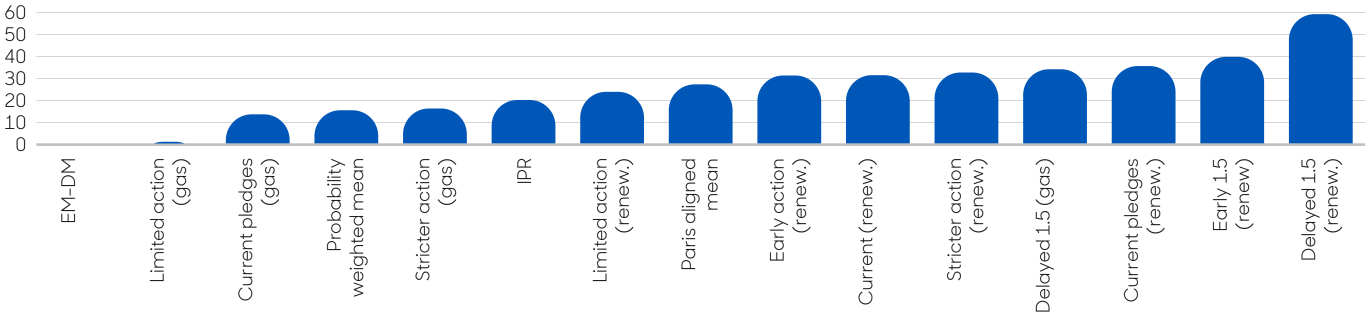
across firms within each sector is much greater again. This highlights one of the most important takeaways from our climate-scenario exercise: that climate risk and opportunity is largely a micro or stock-specific phenomenon.

Figure 14 shows the dispersion of net impairment estimates across all the firms in the MSCI World index, under our mean scenario, for each aggregate sector. It is clear from the figure that the sector averages often say little about how an individual firm is likely to be impacted under a given scenario. Indeed, significant dispersion is evident in almost all sectors, with many instances of negative impairment in sectors that are on average positively affected in this mean scenario (and vice versa).

The utilities sector is perhaps the best example of why investors should not focus too much on sector aggregates. Here, the 18% average positive effect masks negative impairments as high as 60%, as well as many positive impairments greater than 100%. This dispersion is created by the fact that, within an aggregate sector, business models – and thus exposure to the different drivers of impairment – vary enormously.

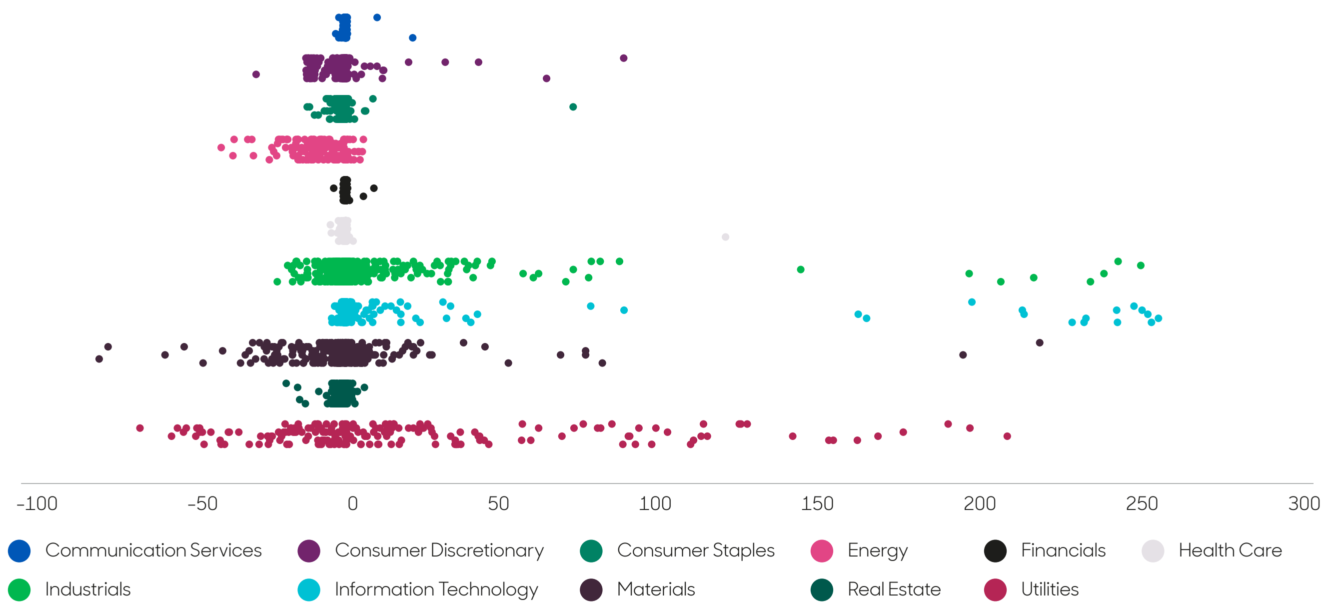
This can be seen more clearly by splitting the utilities sector into six sub-sectors – renewable electricity; gas utilities; multi-utilities; electric utilities; independent power producers and energy traders; and water utilities – and then examining how our scenarios affect the sub-sectors

Figure 13: The utilities sector is positively affected in all of our scenarios (%)



Mean total impact in the utilities sector under each scenario (means-weighted by market cap) relative to what is priced into the baseline. Data source: Planetrics and abrdn analytics, January 2021.

Figure 14: Estimated impairments are highly dispersed within sectors

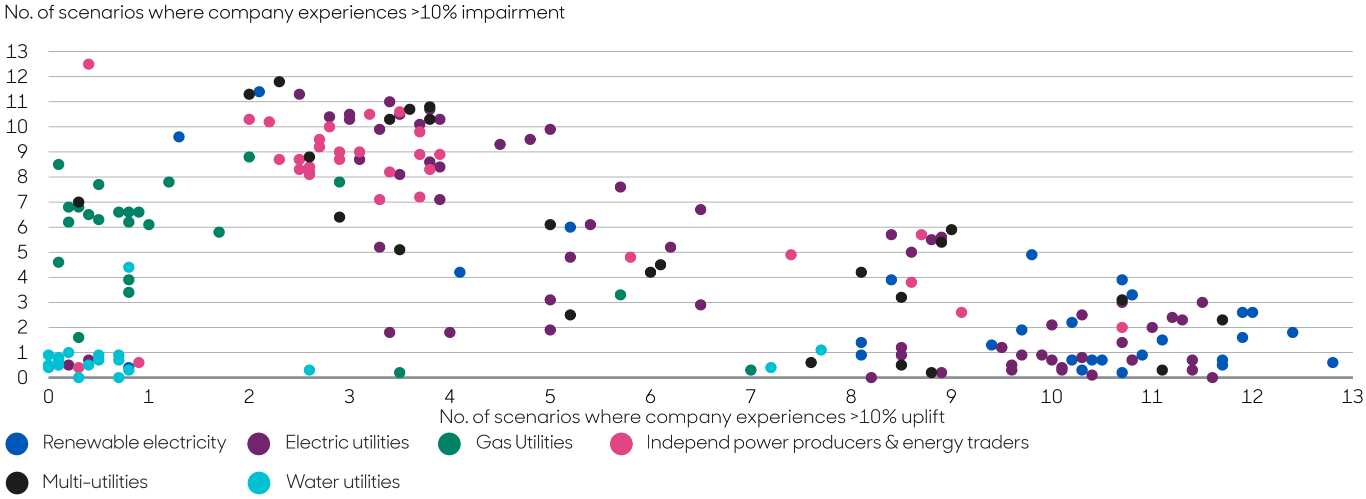


Dispersion of total impact across all companies in the MSCI World index for each sector (probability-weighted mean scenario). Outliers beyond 200% are not shown. Data source: Planetrics and abrdn analytics , January 2021.

differently (see Figure 15). In general, most of the differences are accounted for in the sub-sectors' levels of reliance on revenues derived from fossil fuels. As carbon prices rise and the relative cost of renewable technologies fall – particularly in our more stringent policy-action scenarios – more fossil-fuel-reliant firms suffer in both absolute and relative terms.

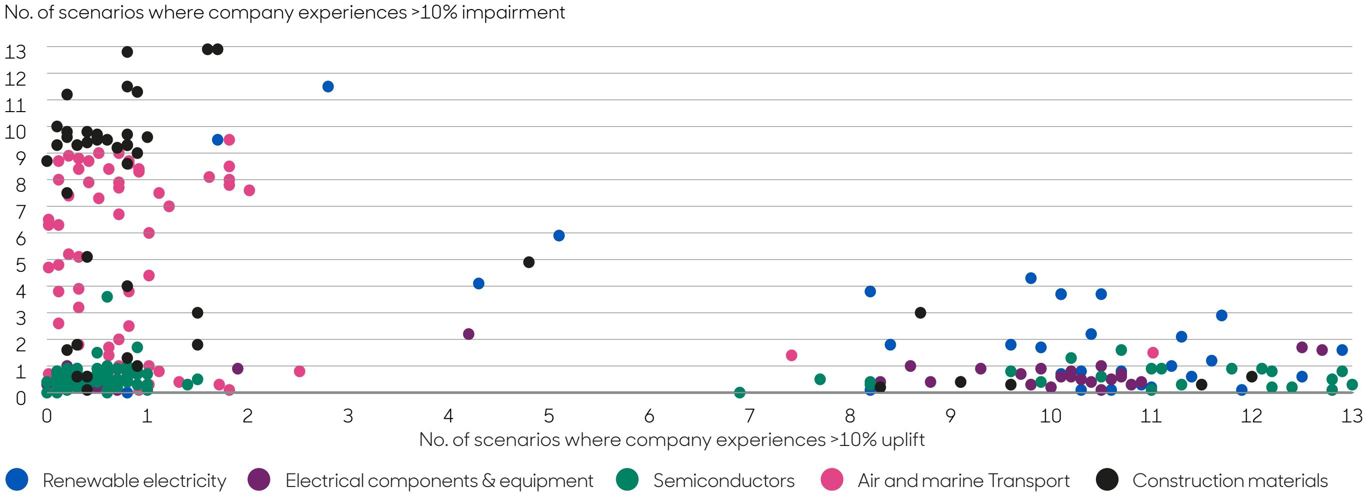
Two sub-sectors underscore this point. The vast majority of renewable-electricity firms experience positive uplifts in more than half of the scenarios, including the mean and Paris-aligned scenarios. Within the renewable-electricity sub-sector, solar companies do particularly well, making up the majority of the firms experiencing uplifts greater than 100% in the significant-energy-transition scenarios.

Figure 15: Distribution of sub-industry uplift and impairment across the global utilities sector



Distribution of uplift and impairment across sub-industries in the utilities sector. Data source: Planetrics and abrdn analytics, January 2021.

Figure 16: Resilient winners and common losers



Distribution of uplift and impairment across selected sub-industries. Data source: Planetrics and abrdn analytics, January 2021.

In contrast, the majority of gas utilities suffer negative impairments in the majority of scenarios thanks to the higher carbon costs and larger amounts of demand destruction they have to absorb.

Renewable-electricity firms are what we might call 'resilient winners' (positive uplift in a majority of scenarios) while gas utilities are 'common losers'. These insights can be broadened into other sectors as well (see Figure 16). Among the other most important resilient winners are the following:

- **Electrical components and equipment manufacturers**. The industrial sector as a whole experiences a modest positive uplift in the majority of our scenarios, in part because mitigation policies are on average assumed to be weaker but also because there are a lot of offsetting impacts at the sub-sector level. Electrical components and equipment manufacturers contribute disproportionately to the positive average effect as many are expected to be key parts of the low-carbon-energy supply chain, whether by producing solar panels for the power sector or the fuel cells essential to electric vehicles.
- **Semiconductor manufacturers**. The vast majority of the aggregate uplift for the information technology sector in the mean scenario is accounted for by the producers of semiconductors. That is because semiconductors are an essential component of many low-carbon technologies, including electrical vehicles.

While firms operating in fossil-fuel-intensive activities across the energy, utilities, materials and industrials sectors are naturally where most of the common losers are to be found, there are some other types of company worthy of investor attention:

- **Long-range transportation**. The average air and marine transportation sub-sector is negatively impaired in all but one scenario – current policy. This is because these firms are subject to some of the highest carbon costs in climate-action scenarios, suffer from significant demand destruction and have many fewer abatement opportunities. That is in contrast to automotive companies, where advances in battery technologies offer the potential for a substantial pivot towards electrical vehicles over the longer term. Indeed, the high electric-vehicle penetration we expect (more than 60% in our mean scenario) will carry benefits right throughout the supply chain from the provision of key input metals like cobalt and lithium to battery and fuel-cell production.
- **Construction materials**. Many construction materials are also very carbon-intensive, with the cement industry the second-largest industrial emitter. Therefore, any scenario in which there is a meaningful increase in carbon costs – through either formal pricing or the costs of new regulations – will be destructive of value, particularly given the limited ability of producers to pass these costs on to end-users.

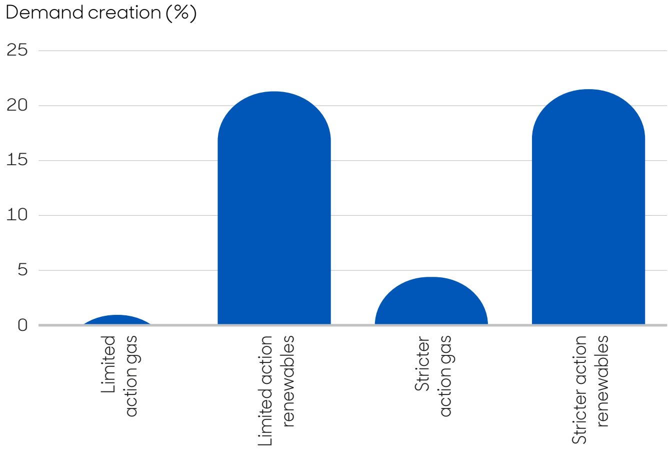
4.3 Technology pathways will determine the winners and losers

Up until now, we have mainly focused on how different degrees of climate-policy action affect sector and sub-sector impairments and their dispersion at the firm level. But an equally important component of our analysis is our ability to examine how different technology pathways influence our assessment of climate risk and opportunity. To recap, the REMIND model is more optimistic about the future of renewable technologies – solar in particular – and the Message-Globiom (M-G) model more pessimistic, forcing most mitigation to take place through negative-emissions technologies like carbon capture and storage.

Figure 17 shows what a difference these technology pathways make to the opportunity facing one sub-sector in particular: the producers of semiconductors. In the REMIND-based models, average demand creation for these firms exceeds 20% whereas in the M-G-based models, demand creation is below 5%, even under stringent policy action. The result is that investors will need to rapidly respond as evidence accumulates as to who the technology winners and losers of the energy transition are.

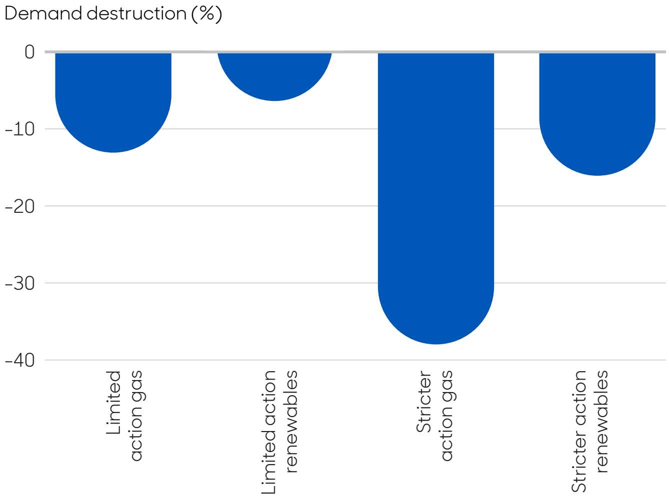
Figure 18 demonstrates the importance of technology pathways from the angle of a sub-sector that is generally negatively affected by the energy transition: oil and gas exploration companies. The faster decarbonisation of the power sector in the REMIND model contributes to a more optimistic outlook for oil demand. As a result, while oil and gas exploration companies still experience demand destruction in scenarios using this model, this is much smaller than in the M-G models, where oil demand falls by a much greater amount. And again, because the future of technology over large timeframes is so uncertain, investors need to take this uncertainty into account when allocating capital.

Figure 17: The technology pathway will matter a lot for producers of semiconductors



Comparison of mean demand creation (weighted by market cap) for the semiconductor industry. Data source: Planetrics and abrdn analytics, January 2021.

Figure 18: Technology pathways will also decide the future of oil and gas exploration firms



Comparison of mean demand destruction (weighted by market cap) for the oil and gas exploration industry. Data source: Planetrics and abrdn analytics, January 2021.

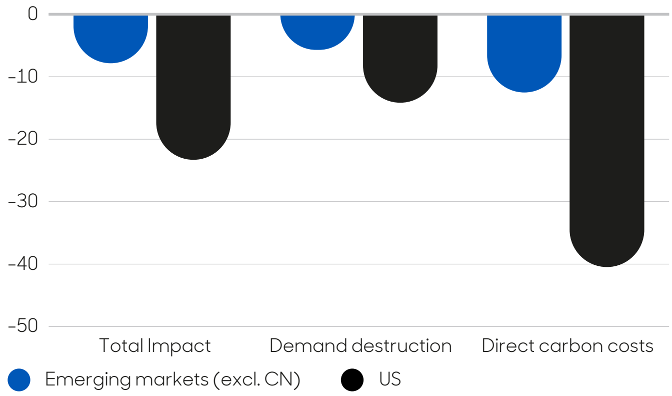
4.4 Bespoke scenarios generate important new insights across regions

Perhaps our largest contribution to the climate-scenario literature is the way we build bespoke scenarios that allow climate policy to vary across regions and the major energy-usage sectors within those regions. In this section, we demonstrate how our more realistic policy assumptions also generate more plausible impairment estimates.

One of the crucial assumptions we make is that climate-policy action in emerging markets is likely, on average, to be smaller in scale and more delayed compared with the advanced economies. The importance of this assumption can be seen by taking a closer look at how US oil and gas companies are affected differently from oil and gas companies in emerging economies (excluding China) in our early-action renewables bespoke scenario (see Figure 19).

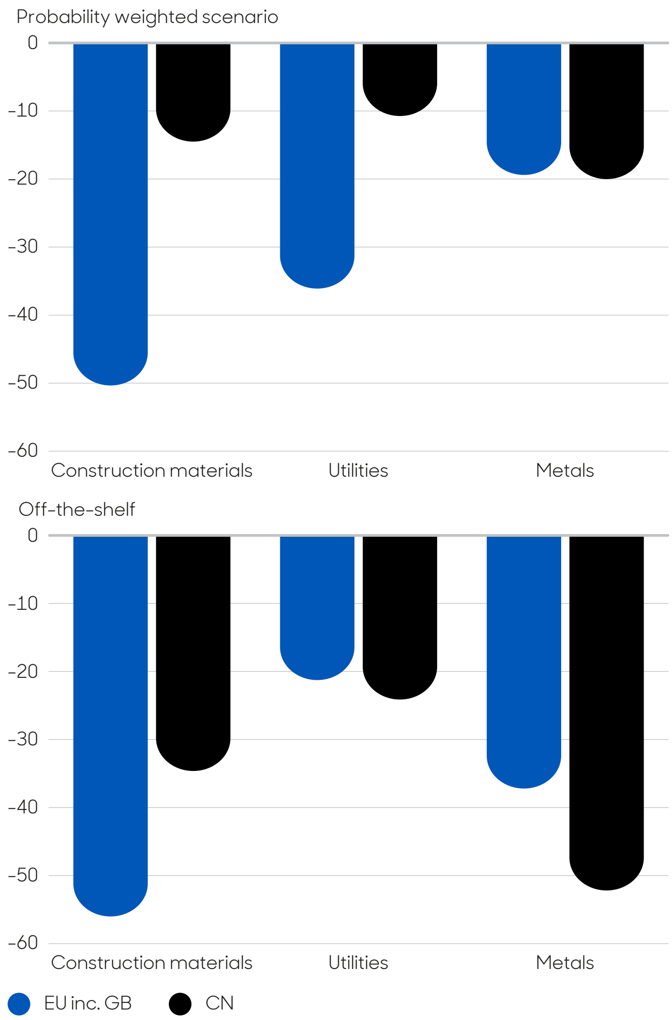
In both cases, the average firm experiences negative impairment, consistent with lower demand for oil and gas relative to the baseline and higher direct carbon costs. However, the average emerging economy is less negatively affected because its energy transition towards renewables is slower and less complete than in the US, carbon pricing is less prevalent and breakeven oil prices are lower. In practice, there will also be significant variation in impacts across emerging economies, reflecting the likelihood of significant policy differences. But the general point about considering the risk and opportunity differently remains an important one for investors.

Figure 19: Oil and gas companies suffer less impairment in emerging economies (%)



Comparison of impact on oil and gas companies for selected regions in the early (renew.) scenario (means weighted by market cap). Data source: Planetrics and abrdn analytics.

Figure 20: The importance of allowing for carbon pricing to vary across regions (%)



Comparison of mean direct carbon cost (weighted by market cap) for selected regions and sub-sectors a) Probability weighted mean scenario; b) Mean of all off-the-shelf scenarios. Data source: Planetrics and abrdn analytics.

The benefits of our bespoke approach are further highlighted by comparing the relative performance of European and Chinese companies in three key sectors – construction materials, utilities and metals – and between our weighted mean scenario and a simple average of the seven off-the-shelf scenarios we drew on in our analysis. Direct carbon costs weigh on the average firm's earnings and thus its fair value in both regions and in both types of scenario. But in our bespoke scenario, which allows for regional policy variation, these costs are larger in Europe than in China, rather than smaller, because there is stronger policy action in Europe (see Figure 20). As in our previous example, relaxing the assumption of policy universality leads to different and more plausible insights.

4.5 A case study to bring our results together

In Chapter 2, we drew on a highly stylised example of how two different types of utility might fare in the two tails of the climate-risk distribution, to demonstrate the building blocks of our climate-scenario framework.

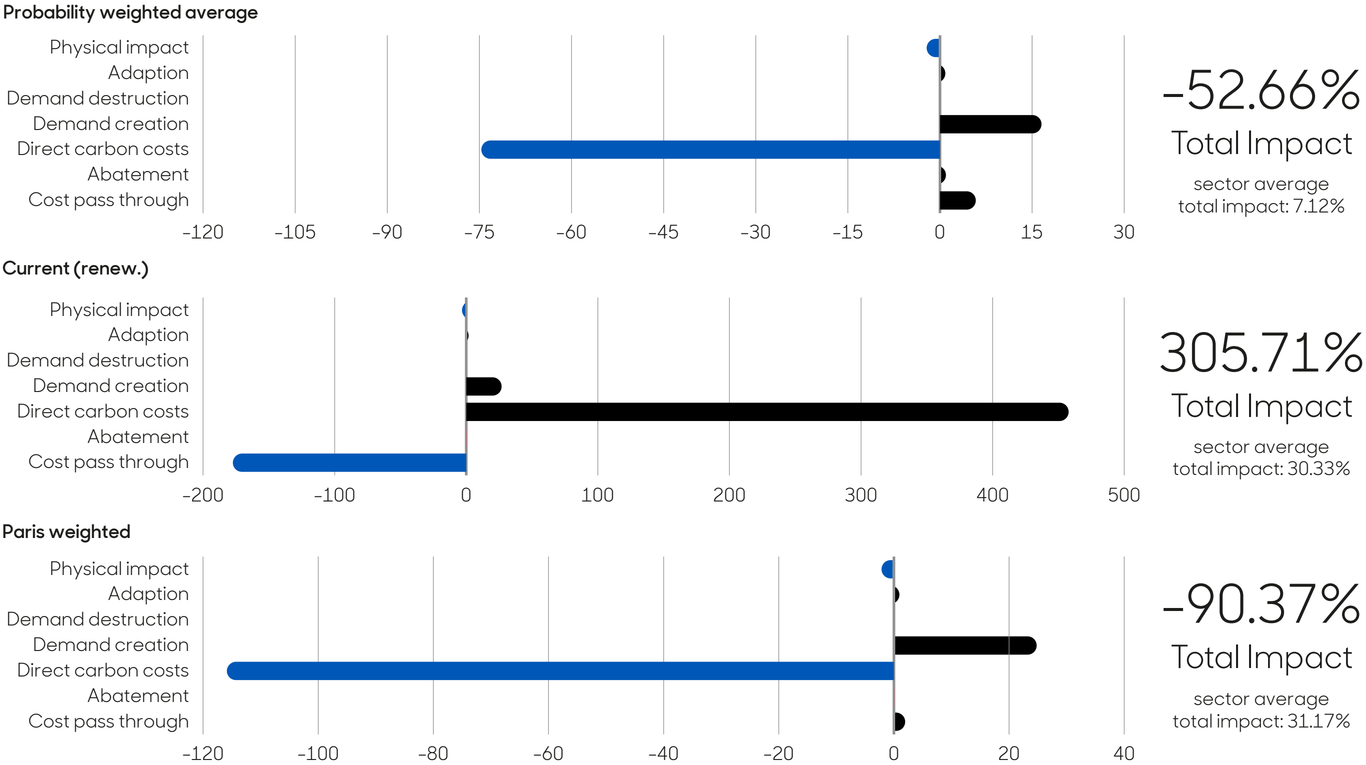
To bring all of the insights from this chapter together, we finish with a case study that 'unblinds' the companies A and B to show that our framework can be used to pinpoint the implications of our different plausible climate scenarios on their fair value and the drivers of our estimates.

US utility company Evergy is CoalGenCo and suffers negative impairment greater than 10% in 12 of our scenarios. Evergy generates two-thirds of the power it supplies from hydrocarbons, the majority of which comes from coal-fired power plants. Figure 21 decomposes the total impairment estimates for Evergy into its seven core drivers, under three scenarios: our mean scenario, the Paris-aligned scenario and current policy.

Unsurprisingly, our Paris-aligned scenario has highly detrimental implications for the value of Evergy. Direct carbon costs are extremely high and would be enough to prevent Evergy from remaining a going concern if it were not for its ability to benefit from some offsetting demand creation. Critically, Evergy has no ability to pass on its higher costs to end-users because it is competing with many much less carbon-intensive utilities, leaving it with a net negative impairment of 90%.

The mean scenario also carries very negative implications, albeit less extreme. The intuition here is that the power sector is likely to be the focus of carbon mitigation by US policymakers. Therefore, estimated carbon costs are still very high. Indeed, Evergy is the most negatively impaired US utility (and one of the worst-affected companies across all sectors) in both the mean and the Paris-aligned scenarios. On the other hand, Evergy benefits enormously

Figure 21: Evergy has a lot to lose from the energy transition (%)



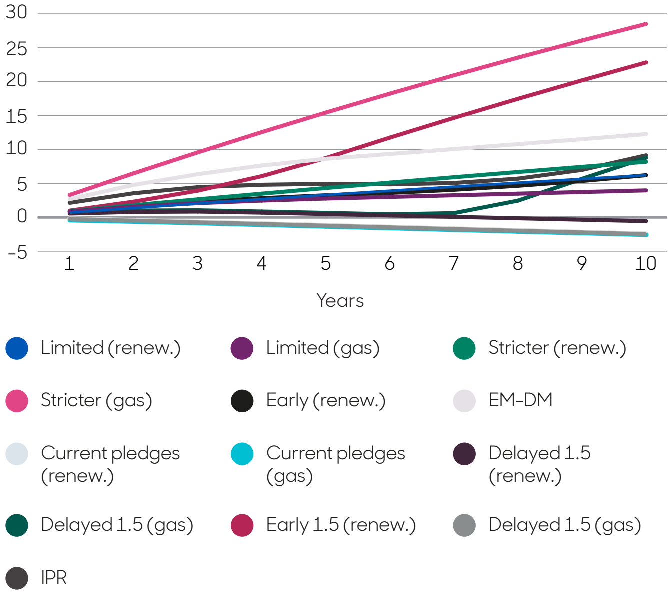
Impact drivers and total impact for Evergy under the probability-weighted mean, current (renew.) and Paris-aligned mean scenarios. Impairment estimates should not be regarded as either forecasts or projections, and do not represent investment recommendations of any kind. Data source: Planetrics and abrdn analytics, January 2021.

from our current policy scenario, mostly because there is no meaningful carbon pricing, in contrast to our baseline scenario, which assumes modest increases in carbon prices over time.

It is also important to consider the implications of our scenarios for the value of the debt Evergy issues. Given that earnings changes are the primary driver of credit-impairment estimates, it is unsurprising that in all the scenarios in which Evergy's equity valuation is negatively impaired, so is its credit valuation, as default probability rises with negative earnings impacts (see Figure 22). That said, and as foreshadowed earlier in the chapter, estimated credit impairments for Evergy are lower than equity impairments in all scenarios.

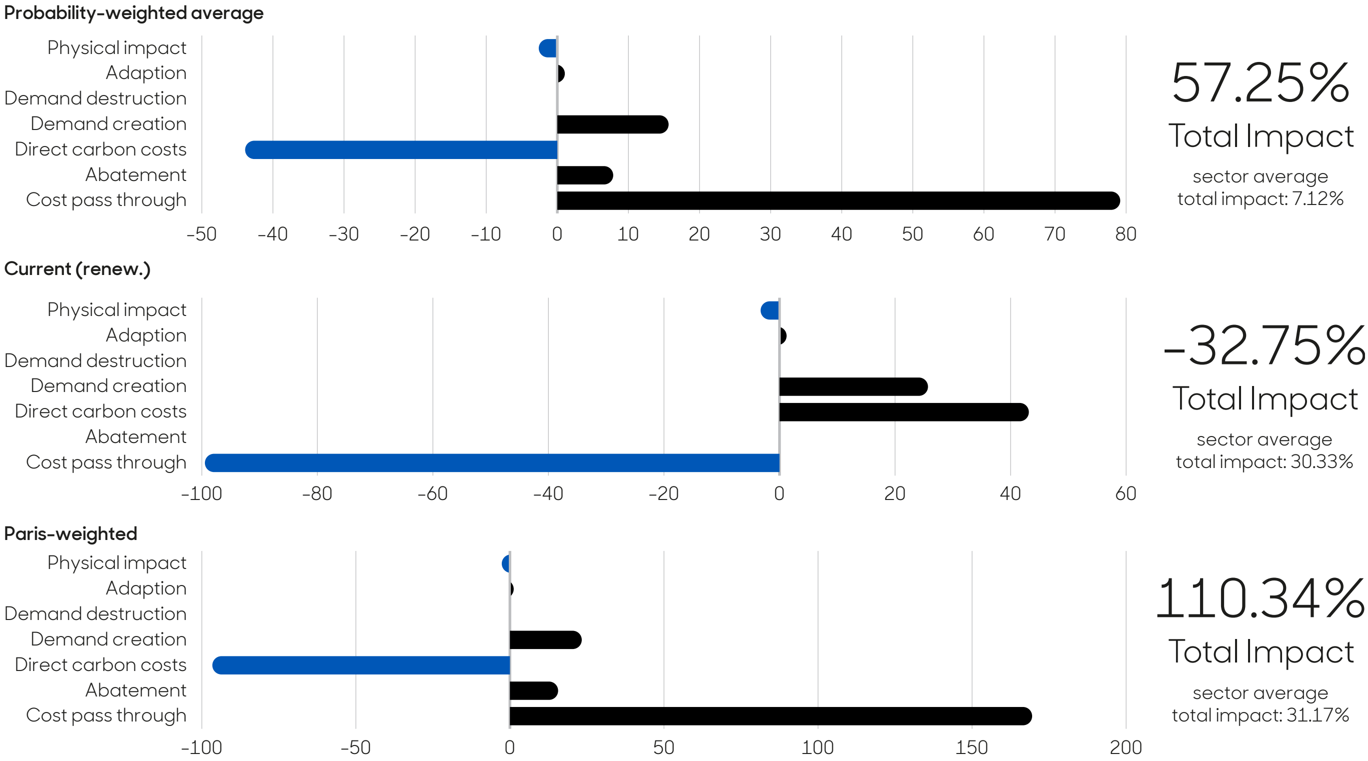
European utility Iberdrola is RenewCo and experiences an uplift of greater than 10% in 12 of our scenarios. Iberdrola is one of the world's leading producers of wind power. As such, the company experiences a large positive uplift in both the mean and Paris-aligned scenarios (see Figure 23). In both scenarios, the company does face a drag from higher carbon costs because not all parts of its energy supply chain are carbon-free. However, these higher carbon costs are more than offset by the

Figure 22: Evergy is also likely to suffer credit impairment under most scenarios (%)



Cumulative probability of default (years 1-10) for Evergy under all scenarios.
Data source: Planetrics and abrdn analytics, January 2021.

Figure 23: Iberdrola would be a large beneficiary of an acceleration in the energy transition (%)

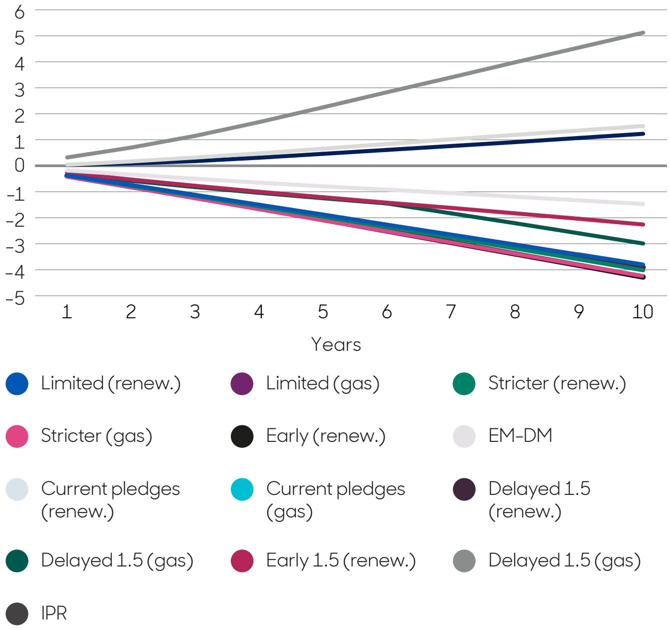


Impact drivers and total impact for Iberdrola under the probability-weighted mean, current (renew.) and Paris-aligned mean scenarios. Impairment estimates should not be regarded as either forecasts or projections, and do not represent investment recommendations of any kind. Data source: Planetrics and abrdn analytics, January 2021.

ability both to pass on its own higher costs and to benefit from the general increase in European electricity prices generated by the rise of carbon prices over time. In the current policy scenario, Iberdrola suffers from significant negative impairment.

This is largely because Europe's failure to impose higher carbon prices in this scenario, relative to the baseline, causes a significant erosion in the company's margins in light of its higher relative costs vis-à-vis fossil fuels. Meanwhile, the corollary of Iberdrola's equity uplift in most scenarios is that its credit-default risk falls in most scenarios, leading to an uplift in the fair value of its debt relative to the baseline (see Figure 24).

Figure 24: Iberdrola's credit-default risk also lower in faster energy-transition scenarios



Cumulative probability of default (years 1-10) for Iberdrola under all scenarios. Impairment estimates should not be regarded as either forecasts or projections, and do not represent investment recommendations of any kind.
Data source: Planetrics and abrdn analytics, January 2021.

Part 5: Using our scenario insights to deliver superior client outcomes

The results of our climate-scenario analysis provide insights at portfolio, sector, region and asset level for all 14 scenarios, as well as our probability-weighted aggregate and Paris-aligned scenarios. We then incorporate these insights into the key stages of our investment process, as well as the development of climate-driven solutions, to deliver superior outcomes for our clients (see Figure 25).

5.1 Developing an enhanced, climate-aware approach to active stock selection

Incorporating the risks and opportunities related to climate change into active stock selection is often based on publicly disclosed and backward-looking data such as carbon-emission trends. While this information is useful for setting a baseline, understanding historic trends and assessing the company's current exposure to different risks and opportunities, the more important question for active stock election is: how well is the company positioned for the future?

"A robust basis for incorporating climate-change risks and opportunities into our research process to drive investment decisions and engagements."

Figure 25: Results of climate scenario analysis feed into our investment process & solutions development

Stock-level research – Identify risks & opportunities based on impact variation within sectors & regions and understand characteristics of winners & losers

Corporate engagement – Incorporate insights into engagement to understand risk mitigation and resilience, challenge strategies and encourage disclosure

Strategic asset allocation (SAA) – Reflect implications of climate scenarios on aggregate risk and return opportunities

Investment solutions – Construct climate-resilient portfolios and climate-driven products and benchmarks to support the low-carbon transition

The outputs of climate-scenario analysis help answer this question by providing a quantified foundation for forward-looking assessments of the risks and opportunities of different climate scenarios. As we have seen, the most important insight from our analysis is that likely financial impacts are highly dispersed across firms and within sectors, with average sector and index-level effects generally modest. This helps identify the companies most at risk and those best positioned for the opportunities related to the energy transition – an important input for active stock selection.

To incorporate climate change into the active stock-selection process, investment decision-makers need to be able to answer a number of key research questions at the regional, sector, sub-sector and stock level. The rest of this section outlines those questions and brings them to life, using the metals and mining sub-sector within the materials sector as a case study.

10 key research questions

The questions below can be answered across all scenarios, but the research focus should be on the mean scenario and the tail scenarios (Paris-aligned and current policy):

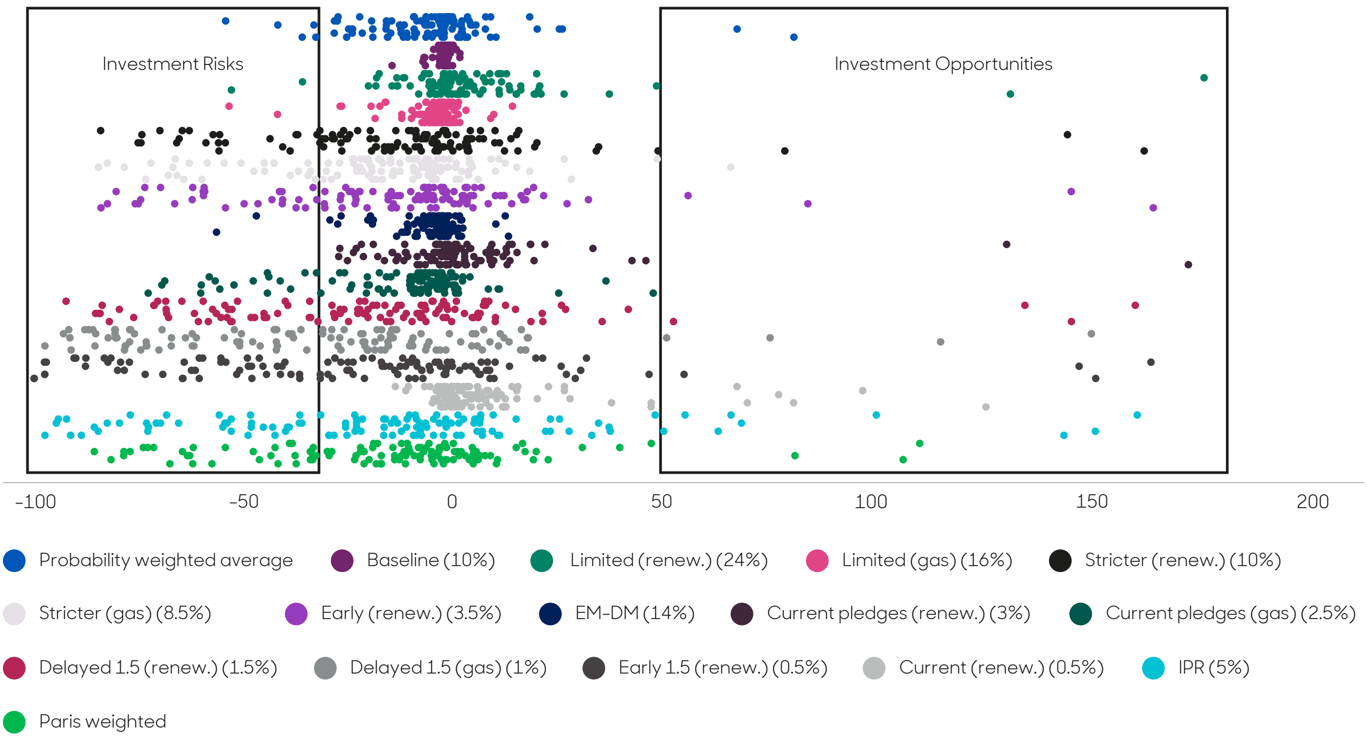
1. **Sector impact and dispersion** – How is a sector impacted across the different scenarios, and what is the dispersion of impacts around the sector mean?
2. **Impact drivers** – What are the key drivers of value creation and destruction for the sector?
3. **Regional analysis** – How do sector impacts and dispersion differ by region?
4. **Sub-sector analysis** – Which sub-sectors are consistently impacted by more than 10% (positively and negatively) across different scenarios, and why?
5. **Winners & losers** – Which stocks are most positively and negatively impacted within a given sector or sub-sector (top & bottom 10), and how does this align with internal stock recommendations?
6. **Stock-level impact** – How is a specific company impacted in terms of value and survival probability across the different scenarios compared to the mean impact for that sector or region, and why?
7. **Impact channels vs peers** – What are the main impact drivers for the company (e.g. physical risks, demand destruction, carbon costs), and how does this compare to peers globally?
8. **Earnings growth** – How does mean-climate-scenario-implied earnings growth for a particular company differ from internal estimates, and why?
9. **Asset prices** – Do we believe that the implied impacts have been incorporated (partially or fully) into asset prices by the market since the impairment estimates were calculated?
10. **Transition & mitigation strategy** – What actions is the company taking and what transition strategies does it have in place that are not captured in the climate-scenario analysis and could be sufficiently material to alter internal views of the likely impacts?

Figure 26 shows the impact on metals & mining across all scenarios analysed and the dispersion within the sector. In more stringent transition scenarios, we can see a predominantly negative impact on companies with only a small number of 'winners'. In the probability-weighted scenario, the impacts are smaller and less dispersed because this scenario does not lead to much change relative to what is already in the price.

A good starting point for identifying material climate risks and investment opportunities as part of the research process is to understand the impact drivers for the sector (See Figure 27 below) and how they differentiate between sector winners and losers. Direct carbon costs increase in more stringent Paris-aligned scenarios as metals & mining activities such as extraction and processing are often very carbon-intensive.

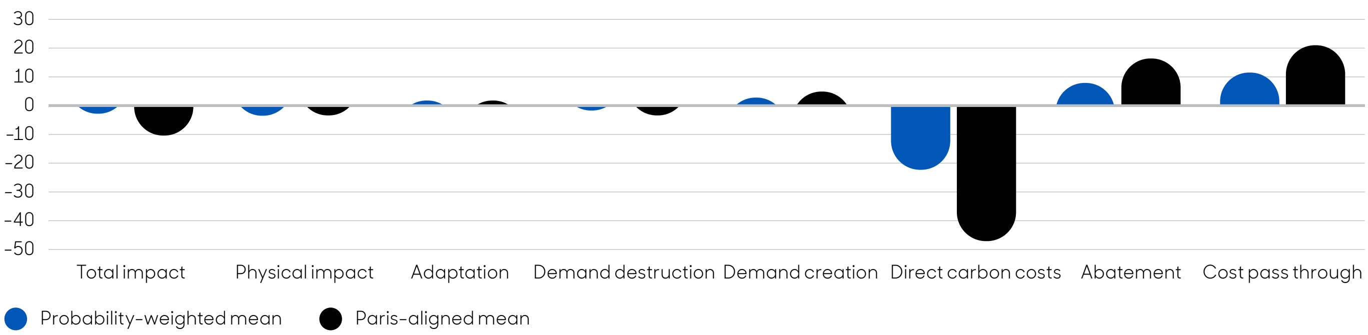
However, there are also opportunities to pass costs on to customers, which partially offset these higher costs. Although mining companies tend to be price-takers in global commodity markets, the imposition of direct carbon costs is a shock common to all producers (although each has a different cost structure), especially

Figure 26: Stricter transition scenarios result in more impairment for metals & mining



Dispersion of total impact across all metals & mining companies under each scenario. Outliers beyond 200% are not shown. Data source: Planetrics and abrdn analytics, January 2021.

Figure 27: The impact of valuation drivers scales up under stricter transition scenarios (%)



Comparison of total impact and valuation drivers (means-weighted by market cap) for the metals & mining industry. Data source: Planetrics and abrdn analytics, January 2021.

in our stricter-action scenarios that assume increased mitigation efforts in all sectors and regions. Therefore, because the entire supply curve for a given commodity shifts and the demand for affected commodities is not completely inelastic, there is scope for some of the higher costs to be passed on to end-users.

Abatement options become more available and viable in more stringent transition scenarios. Demand creation for non-fossil-fuel commodities is also higher in Paris-aligned scenarios, reflecting higher demand for certain commodities that are needed to facilitate the energy transition, such as lithium, cobalt and copper.

Looking at the top and bottom 10 companies impacted helps us identify which types of companies are most vulnerable to the transition and which are the greatest beneficiaries. Within metals & mining, the most negatively impacted companies in the mean scenario are **steel producers**. In contrast, the most positively impacted companies are, unsurprisingly, those focused on metals most needed for the transition – **two lithium miners** (Chinese and Australian, captured within diversified mining) and **one copper miner** (Mexican) are among the five most positively impacted companies.

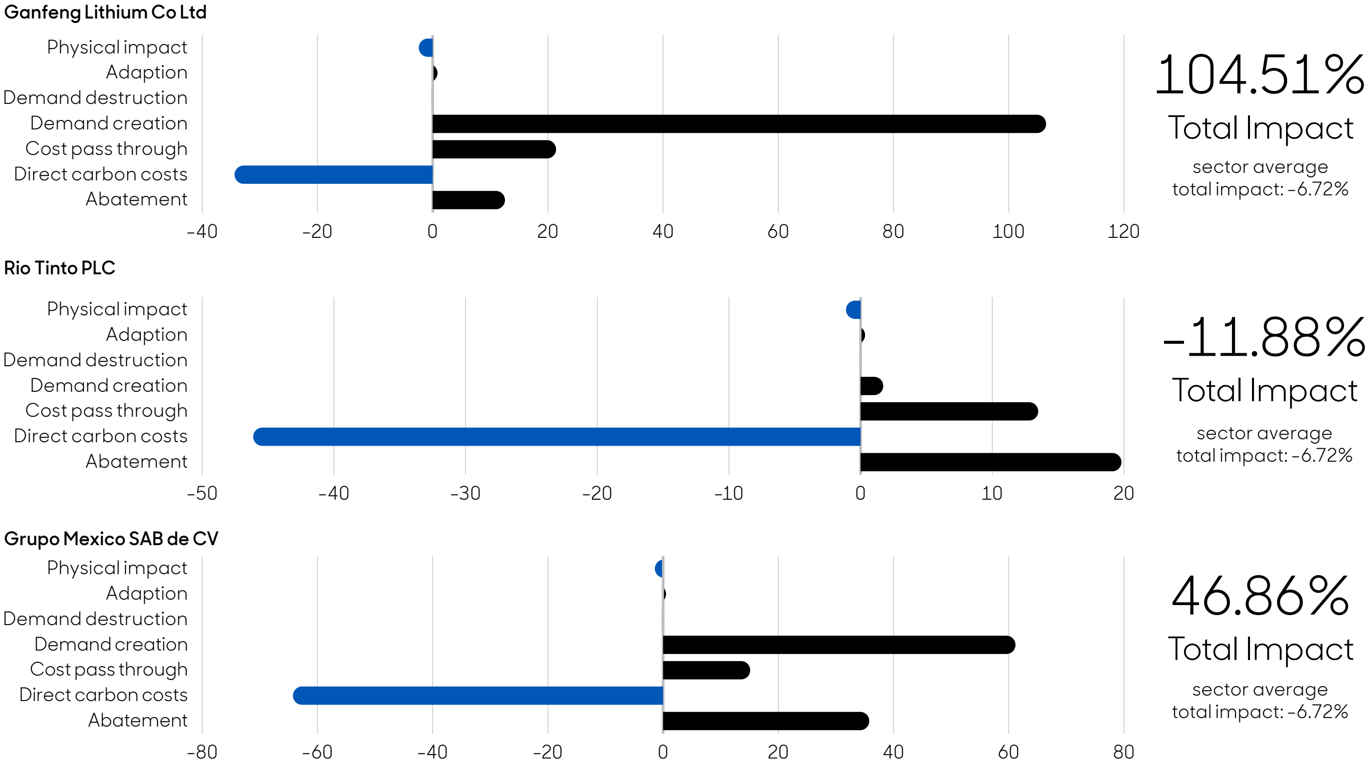
The next step is to drill into individual stocks of interest. In our research process, these would be selected because we have some exposure, because there is a strong fundamentally driven investment view, or because they stand out as among the most impacted companies in the sector – positively or negatively.

Figure 28 compares a highly diversified miner that is also one of the largest aluminium producers, one Chinese lithium company and a Mexican copper miner and how they are impacted in the Paris-aligned mean scenario.

Our scenario analysis shows that the two mining companies that specialise in producing metals needed for the energy transition fare much better than the diversified miner in scenarios in which there is a significant energy transition.

The explanation for this result is fairly intuitive. Direct carbon costs are highest for the diversified mining company because its portfolio includes fossil fuels. Demand creation is lowest. And while this company does have some potential to pass its higher costs on to end-users, it isn't enough to offset its very high direct carbon costs.

Figure 28 Impact of the Paris-aligned mean scenario on different types of miners varies considerably



Impact drivers and total impact for three mining companies under the Paris-aligned mean scenario. Data source: Planetrics and abrdn analytics. Impairment estimates should not be regarded as either forecasts or projections, and do not represent investment recommendations of any kind. Data source: Planetrics and abrdn analytics, January 2021.

In contrast, while the lithium and copper-focused producers also face higher direct carbon costs in energy-transition scenarios, these are more than compensated for by significant demand creation (both are critical to the expansion of electrical vehicles), the ability to pass those higher costs on and new abatement opportunities.

Steel producers are hit the hardest hit within the sector

As highlighted above, steel producers are the hardest-hit sub-sector in the wider metals & mining sector. They tend to be negatively impacted across transition scenarios given their high carbon intensity and limited affordable abatement options. Within this sub-sector, there is, however, still dispersion, in part because of regional variation in climate policies and differential abilities to pass higher costs through the supply chain.

Figure 29 illustrates this by comparing illustrative Chinese and European steel companies under the Paris-aligned mean scenario. The European company has the highest carbon cost, reflecting more stringent climate policy in Europe and little abatement potential as decarbonisation is a challenge for the sector. The Chinese steel company has lower, though still significant, carbon costs and a greater ability to pass costs to end-users. It is also, however, hit a lot harder by physical risks than the European and US company as these will differ significantly by region. Thus, while it still suffers from negative impairment and stringent policy action, the impairment is smaller than for the European company.

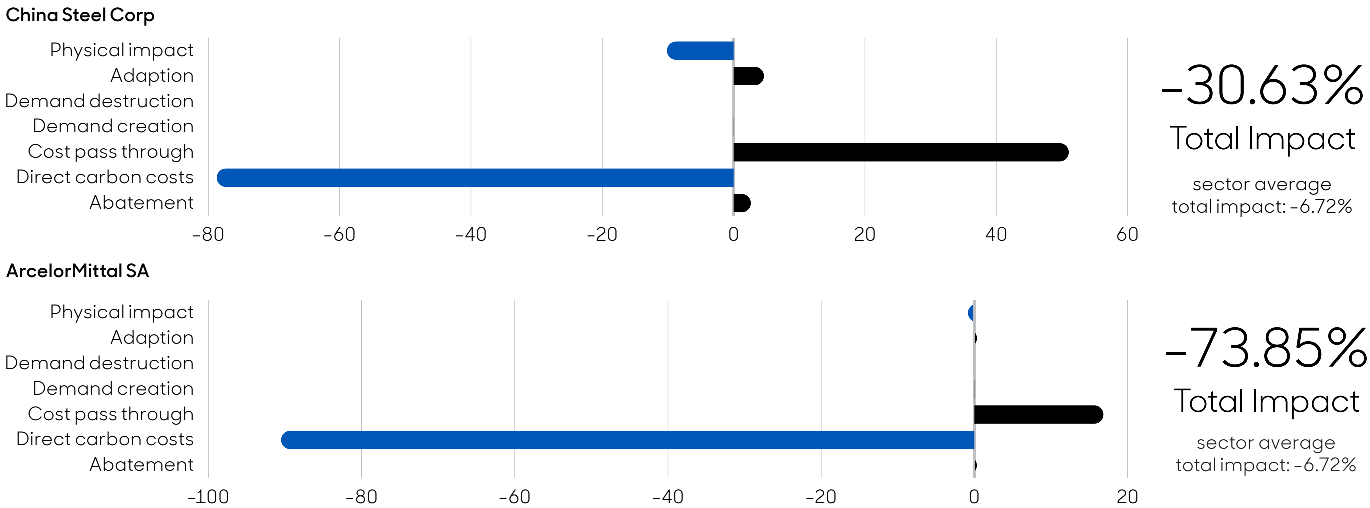
Next, a deep dive into one specific company can be undertaken to explore the risks and opportunities it is facing across our scenarios relative to its peers. Figure 30 provides an example of how this is done for BHP, a major diversified mining company. Three scenarios are highlighted to show how the company is affected in our mean and key-tail-risk scenarios.

The company is relatively unaffected in our mean scenario because higher carbon costs and demand destruction in fossil-fuel-related activities are offset by cost pass-through and demand creation for commodities that would be in higher demand. Paris-alignment, on the other hand, leads to a large, though still modest, negative impact. Meanwhile, the maintenance of current policy would be very positive for the firm because there is no carbon pricing and the demand for its aggregate portfolio is significantly higher than in the baseline.

We have also enhanced the climate-scenario analysis with additional information to help understand the company's contribution to climate solutions by including information on revenue that is considered to be aligned with the EU taxonomy. The data is still immature and incomplete, but it is a starting point for considering the importance of green revenues.

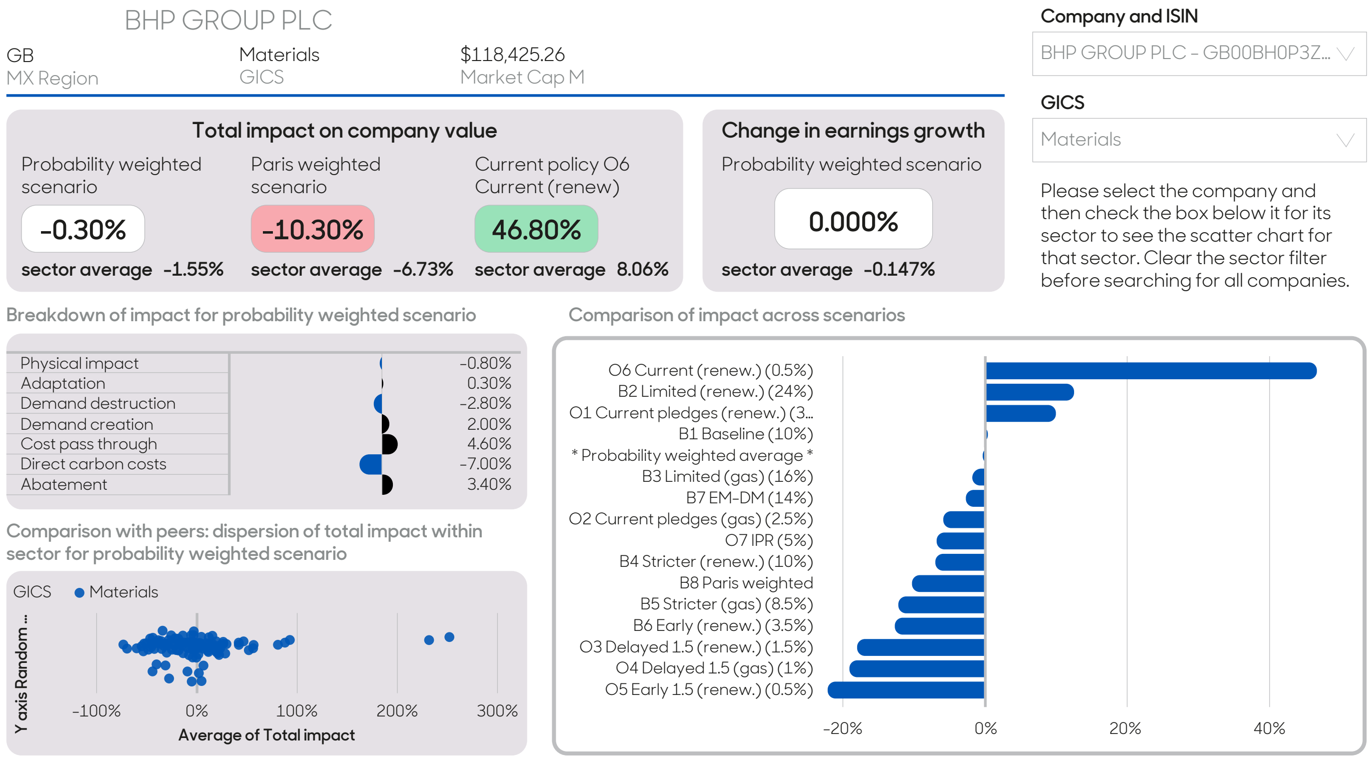
Of course, at this stage, it is important to consider how the change in earnings growth compares with our own estimates, considering factors that the climate modelling cannot take into account, and whether we believe that some of the impact has already been reflected in the price of the stock. The next section focuses on one particularly important factor: dynamic changes in companies' business strategies.

Figure 29: Steel producers are hit hardest, but the impact varies across regions



Impact drivers and total impact for China Steel and ArcelorMittal under the Paris-aligned mean scenario. Impairment estimates should not be regarded as either forecasts or projections, and do not represent investment recommendations of any kind. Data source: Planetrics and abrdn analytics, January 2021.

Figure 30: Climate scenario analysis can be used to produce company reports



Example Company View report. Impairment estimates should not be regarded as either forecasts or projections, and do not represent investment recommendations of any kind.

Recognising how companies are transitioning to manage climate risks

A research analyst must finally ask what actions the company is taking to mitigate the risks identified with credible transition plans. Climate scenario analysis on its own is not suitable for identifying credible-transition companies as the assessment does not at this stage incorporate future company targets, plans and strategies. For example, estimates of future demand creation are based on existing green revenues, not whether the company is altering its strategy to benefit from those changes in demand. Therefore, understanding how companies are planning to mitigate the risks identified requires active, in-depth research and engagement.

Mitigation actions could, for example, include plans to significantly shift the company's energy mix or cost structure beyond what the modelling implies, gain big market share within a growing sector (e.g. climate solutions), to enter or exit a market, and to develop a new technology. If these actions are considered to be material, they should change our view of the picture that the scenario-analysis results suggest. Companies might also have mechanisms in place to manage the negative impacts identified by the analysis: for example, agreements to hedge their carbon costs (though these come at a price, which is likely to increase over time in scenarios with strong climate action).

This company-transition analysis can also be complemented by incorporating data sources such as the Transition Pathway Initiative (TPI) assessment of transition-management quality. Using the steel example above, the TPI compares the quality of transition management of different steel companies on a scale of 1 to 4. Some steel companies are far more ambitious than others when it comes to decarbonisation, innovation and investment.

To illustrate this point, let's take the Chinese and European steel-producer examples shown in Figure 31. The direct carbon costs for the European steel producer are higher, with abatement at only 0.3%, but our research shows that it has ambitious climate goals, invests in innovative technologies to help decarbonise the industry and has been assessed by TPI at the highest level, 4. The Chinese and US steel companies have TPI scores of 3 and 1, respectively, and less strategic ambition to decarbonise. Investing in the European steel producer could therefore have a more positive impact on moving the energy transition forward.

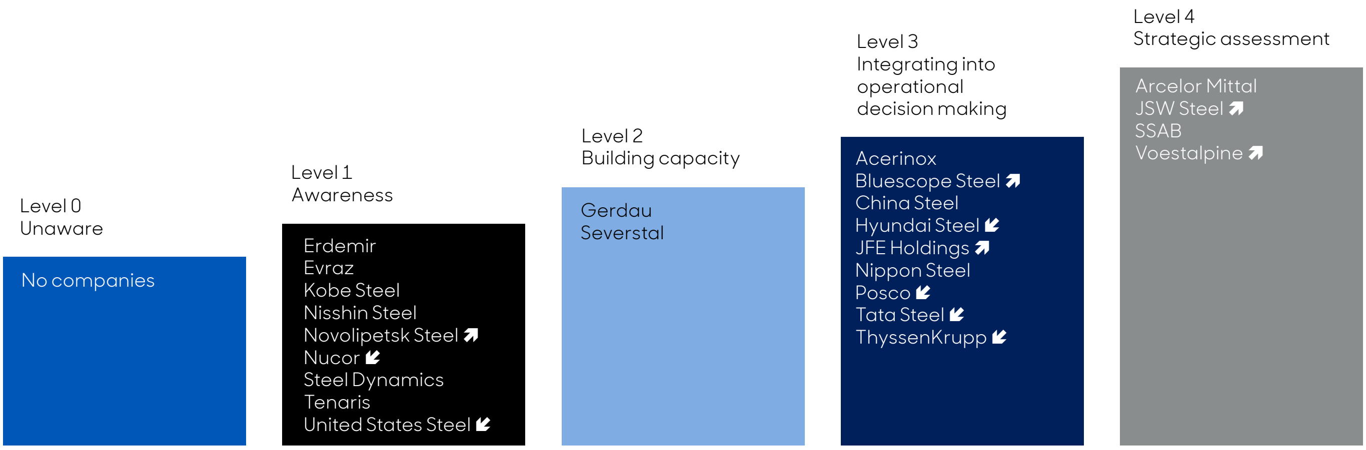
This example shows why the results of climate-scenario analysis should inform but not dictate investment decisions. Stock-level assessments need to be adjusted based on our own understanding of the company and the transition and adaptation plans it has in place. Discussing and validating some of the results highlighted by climate-scenario analysis with investee companies is an important part of the process.

In summary, climate-scenario analysis, provides a robust basis for incorporating climate risks and opportunities into our research, engagements and investment decisions. While our focus here has been at the company level, it is important to also consider how company-level exposures aggregate up into portfolio-level exposures so that they can be managed to appropriately meet client objectives. We return to this topic briefly in Section 5.4.

5.2 Facilitating better and more influential climate-related engagement

A core part of our responsible-stewardship activities is engaging with companies on climate change where this poses a material risk to their business. The results of our climate-scenario analysis will feed into our discussions

Figure 31: TPI assessment of the quality of transition management for steel companies



Source: Transition Pathway Initiative December 2020.

with companies and help identify engagement priorities based on the most material climate risks identified. The approach will differentiate between those companies that already undertake scenario analysis themselves and those that don't.

For those companies that undertake scenario analysis themselves, we are able to challenge their assumptions and get a much deeper understanding of what drives their scenario-analysis results compared with ours. More importantly, we also gain greater understanding of how they are integrating the outputs into their decision-making.

a) Engaging with companies that do not undertake climate-scenario analysis themselves

We plan to discuss our climate results with companies, highlighting the negative impacts identified, and ask what actions they are taking to mitigate risks and build resilience. Where climate risks are material to their business, we will encourage them to undertake their own scenario analysis. Scenario-analysis results can guide engagement priorities, especially in the following cases:

- Our probability-weighted scenario has highlighted a negative impact (as a guide, of over 10%), this impact is considerably more negative than the industry average, and the company lacks a credible transition strategy; and
- The risks facing the company are highly skewed, i.e. it would be highly damaged even under a weak Paris scenario. We would also engage where highly positive impacts might suggest attractive investment opportunities.

The focus is on three questions related to exposure, resilience and management:

1. How do you assess your business exposure to climate-change risks & opportunities?

We want to understand how the business assesses its exposure to climate-change risks and opportunities given that it does not undertake formal climate-scenario analysis. As a core foundation of our climate-change stewardship, we expect companies to use the TCFD framework for climate disclosures and clearly report on the climate-change risks and opportunities that they are exposed to. Where risks are material, companies should not only identify but also quantify that exposure.

2. Do you understand how resilient your business is to different climate scenarios?

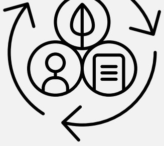
It is also important to challenge companies to consider the uncertainty inherent in climate risks and how sensitive their business is to different policy and technology assumptions. Undertaking climate-scenario analysis is important to assessing their resilience to possible future pathways. Some companies may say that they capture that sensitivity by assessing the financial impact of increasing carbon prices on their bottom line and applying it to emission levels. But this approach is simplistic and does not capture all the other effects an increase in carbon prices would have: for example, on suppliers, customers and the industry overall. Integrated climate-scenario analysis will capture the direct and indirect impacts of climate change and the low-carbon transition more comprehensively and is an important aspect of assessing a company's resilience.

3. What actions are you taking to manage climate risks and build resilience?

And finally, where our analysis suggests that there may be a significant negative impact, particularly in the mean scenario, it is important to understand what actions the business is taking to mitigate these. As mentioned in the previous section, the scenario-analysis results do not provide a view of transition leaders that have set ambitious goals and taken credible action to decarbonise; this is something that can be explored further through engagement. However, it is also important to highlight that the results of the climate-scenario analysis are an important indicator of what the potential impact would be if the company strategy were not actually put into practice.

Following our engagement, we would like to see companies take steps to undertake climate-scenario analysis and take action to build resilience where material climate risks have been identified. We will reflect this in our written stock research and incorporate it into our investment decision-making. This could ultimately result in further engagement, escalation of the issue, reducing our exposure or even exiting our position in the company.

Case study



For one currently very carbon-intensive utilities company, a significantly high direct carbon cost was identified in our probability-weighted analysis. We engaged with the company to understand how it was managing that risk. The company had confirmed that, in the short term, its carbon costs were hedged to minimise risks related to carbon-pricing increases. It had set a 2040 net-zero goal with credible transition plans to significantly increase its renewables market share and decarbonise its business. This was reassuring and enabled us to adjust our view of the company risk and opportunity related to climate change.

b) Engaging with companies that undertake climate-scenario analysis themselves

Only a limited number of companies report on the resilience of their business to climate scenarios – 7% according to the most recent TCFD status report. These are generally larger companies for which climate change is a significant risk, e.g. energy and materials companies, who have the resources to undertake an in-depth exercise into climate scenarios. These are the three core questions to ask:

1. **What scenarios have they used, and how do their assumptions compare with ours and those of their peers?**

   To understand the outputs, it is critical to understand the inputs and assumptions first. Where off-the-shelf scenarios have been used, we know that these often have implausible simplifying assumptions. Asking a company to talk us through its scenario-analysis process and scenario selection demonstrates how much thinking has gone into the analysis and whether there is an understanding of the limitations. It is also useful to understand how the approach compares with those of peers in the industry that have undertaken climate-scenario analysis and how the results compare with our own analysis.

2. **What probabilities do they assign to scenarios?**

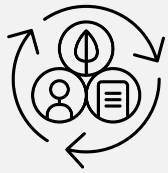
   Very rarely, companies will explicitly publish the probabilities they assign to scenarios. But implicitly, they generally have a view on what scenario is currently most likely, which is what will be driving their investment decision-making. Therefore, probing further on the likelihood of their scenarios and which scenario is driving their planning is important to understanding what is incorporated into their decision-making.

3. **What are the results saying, and what is the company doing with the information?**

   The results of climate-scenario analysis need to be clearly understood and integrated into business strategy and planning. This is often an area that companies struggle to articulate. We expect companies to be transparent on the 'so what' and how resilient they are to a wide range of possible scenarios, including the more extreme scenarios of a 1.5° or >4° world – and to explain how this is reflected in their investment plans.

Asking the three questions outlined above helps us understand how robust a company's internal scenario-analysis framework is and how seriously the outputs are taken by the business. This will be incorporated into our risk assessment of the company and our assessment of the credibility of its transition plans – ultimately feeding into our investment decision-making.

Case study



We engaged with a materials company whose own scenario analysis implied much more positive effects of 1.5°-aligned policies than our own analysis, largely because of optimistic forecasts for demand creation.

We were able to challenge the company by highlighting the likely offsetting impacts of demand destruction and direct carbon costs, and comparing the results with those of peers in the sector. This led to a discussion about the importance of firms drawing on a range of alternative assumptions about transition pathways to adequately assess their resilience.

We also observed that although the company was a vocal supporter of net-zero targets and had set a net-zero operational target for itself, its actual business plans were predicated on a 3° warming outcome because of the lack of credible 2050 net-zero policies. The company had climate-transition signposts in place to review this on a regular basis and adapt its strategy accordingly. This information enhances our understanding of the credibility of the company's transition plan and feeds into our stock research and assessment of how climate risks are managed. We will continue to engage with the company and discuss how its transition plans evolve as global climate policies strengthen.

5.3 Using climate scenarios to enhance strategic asset allocation

One key part of our strategy of integrating climate risks and opportunities into investment processes is the way we are incorporating our climate-scenario analysis into strategic asset allocation (SAA). This involves forming views of the long-term expected returns of a wide range of asset classes and considering how best to combine them into portfolios to meet long-term fund objectives. In undertaking SAA, we need to consider the impact of climate change and wider ESG considerations on expected returns.

abrdn has made a number of changes to its SAA process to incorporate climate and other ESG objectives, as described in our white paper SAA: ESG's new frontier.[1] This experience helped shape the IIGCC Net Zero Investment Framework,[2] which has a strong focus on the role of SAA in enabling investors to meet net-zero objectives. This section outlines how climate scenarios can be integrated into the process to enhance SAA outcomes.

[1] SAA: ESG's New Frontier, abrdn, 2019.
[2] IIGCC Net Zero Investment Framework 2020.

Using scenarios in SAA

Our general approach to forecasting asset-class returns is based on developing a range of economic scenarios. In each scenario, we make different assumptions about prevailing GDP growth, inflation rates and central-bank interest rates. We then form views on the probability of each scenario and generate probability-weighted mean 'expected' returns. These drive our SAA advice to clients.

It is therefore very natural for us to turn to a scenario approach when considering the possible long-term impact of climate change on investment portfolios. We can take a very similar approach, combining our probability-weighted mean expected return of our standard economic scenarios with the mean impairment from our climate scenarios.

The financial impact of the climate transition

As the probability assessment described in Chapter 3 indicates, we currently think that the world will most likely fall short of achieving the Paris Agreement goal of 'well below 2°'. On the other hand, our central scenarios suggest that stronger government policies and improvements in low-carbon technologies mean that an energy transition is underway. Significant change is almost inevitable, with dramatic implications for a number of important business sectors, including energy, transport, heavy industry and mining (see Figure 32).

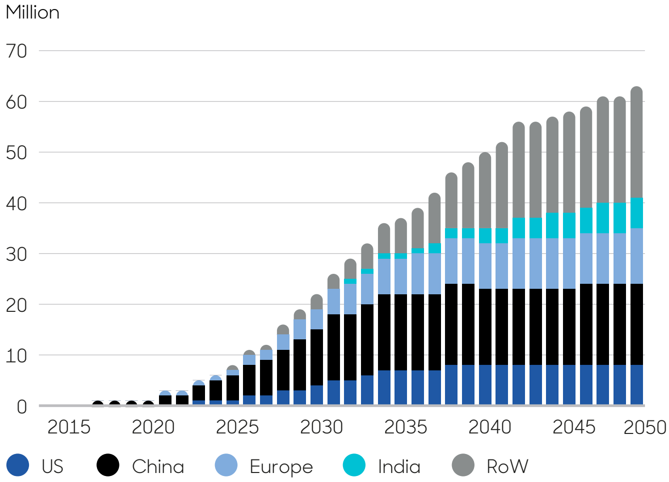
This translates into very high rates of earnings growth for the companies driving the transition in these sectors. Conversely, demand for coal and, eventually, oil and gas will start to fall, suggesting low or negative growth rates in earnings for these sectors, as demonstrated earlier in the paper.

Discounting cash flows

When forecasting long-term equity returns in SAA, we use a simple discounted-cash-flow (DCF) approach of the kind used widely by fundamental equity investors. In this model, long-term investment returns are highly sensitive to earnings growth rates. In the simplest DCF equation,[3] all else equal, the higher the earnings growth rate, the higher the company value. If the winners of the climate transition have the kind of growth rates implied by the charts above, they will have high justified valuations.

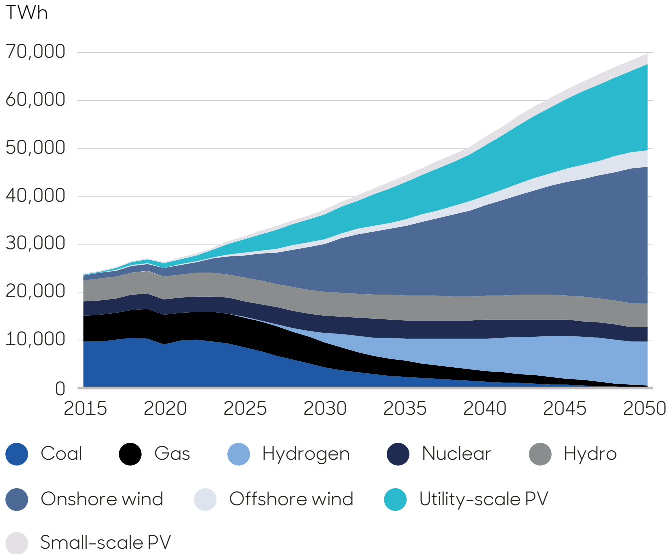
Discount rates matter too. High growth is even more valuable in the current secular economic environment, in which the risk-free component of discount rates is extremely low. This can also be seen in the standard DCF equation. Valuation is an inverse function of interest rates. The lower interest rates go, the higher the valuations.

Figure 32a: Significant growth is expected in electric vehicles and electric power generation – electric vehicle sales by region



Source: Bloomberg New Energy Finance, December 2020.

Figure 32b: Rapid growth is expected in renewable energy generation – electric power generation by source



Source: Bloomberg New Energy Finance, December 2020.

> "abrdn has made a number of changes to its SAA process to incorporate climate and other ESG objectives, as described in our white paper SAA: ESG's new frontier."

[3] P = D/(r-g) where P is fair-value price, D is dividend in year 1, r is discount rate (comprising the risk-free interest rate and the equity risk premium) and g is the earnings-growth rate. Low risk-free interest rates and high earnings growth justify high valuations.

The combination of high growth rates and low interest rates means that climate-solution sectors may justify relatively high expected returns in an SAA context.

High green valuations are scenario-dependent

High growth rates for renewable energy and electric vehicles are likely but not inevitable. If governments were to backslide on their stated climate ambitions, growth would be significantly lower. Similarly, interest rates may not remain at today's historically low levels. For example, they may rise in a more inflationary environment – reducing valuations, particularly for high-growth stocks.

Climate scenarios are invaluable tools that allow us to model this uncertainty. We think it is important to be able to assess the impact on returns across a range of different climate scenarios and to regularly retest assumptions on returns as market prices and climate policies shift. This is what abrdn's climate tools aim to enable.

The impact of climate scenarios on investment returns

As discussed in this paper, we have generated 14 different climate scenarios, with a wide range of policy and technology assumptions, and economic and climate outcomes. These climate-scenario models provide us with a distribution of potential earnings growth and valuation outcomes for individual companies and aggregate indices.

Chapter 4 highlights the key finding that the impact of the mean climate scenario is very small at the level of aggregate equity-market indices like the FTSE 100, S&P 500 and MSCI World. The impact is much larger between and within sectors.

The story is the same for credit indices. The primary difference with credit is bond maturity. The biggest impact of the climate transition on credit risk will be in the 2030s and beyond – for example, as oil demand falls. Bonds that will be redeemed within 10 years are little affected by this risk. It is only the small minority of very long-dated bonds (e.g. an oil company's 20-year bond) that are severely affected.

From an SAA perspective, this means that our standard forecasts for equity and bond indices are little changed. As Figure 33 shows, valuation impact is positive for equities but in the low single digits. If we assume this impact is corrected over 10 years, this translates into changes in return forecasts of a less than half of one percent. This makes a negligible difference for index-level forecasts.

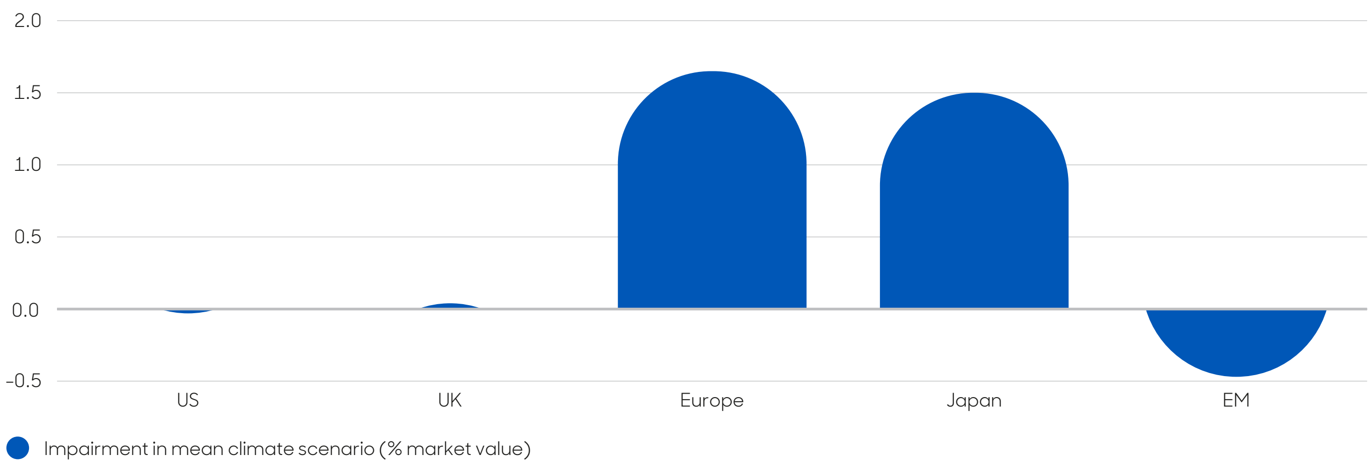
As we explain in our results section, the story is very different across and within individual sectors. Sector valuation impacts are over 10% in some sectors (e.g. oil and gas and utilities) and over 50% for some individual companies. These impacts are big enough to make a substantial difference to SAA forecasts, and to subsequent asset-allocation decisions. They are particularly important to investment strategies that aim to mitigate climate risk or exploit climate opportunity by focusing on these highly impacted names.

5.4 Developing climate-enhanced investment solutions

The results of our climate-scenario analysis are incorporated into our investment solutions to meet two core objectives:

1. Climate-resilient portfolio construction: Making our current investment portfolios more climate-resilient to different pathways by incorporating the risks and opportunities identified in the climate-scenario analysis into our portfolio-construction process.
2. Climate-driven solution development: Developing new climate-driven products and benchmarks to enable clients with climate-specific goals (such as alignment with net zero) to achieve these goals in a research-founded, measurable manner.

Figure 33: Valuation impact of mean climate scenario on regional equity indices (%)



Source: Bloomberg, MSCI, Planetrics, abrdn, September, 2020.

With respect to the first of these, the company-level insights derived from scenario analysis can and should be aggregated into a portfolio-level view of exposures, ensuring that the overall portfolio is climate-resilient and that risks are being managed appropriately. It is important for the manager to consider the interactions and cumulative impacts of climate exposures under different scenario pathways so that as policy changes are announced and as technological developments occur, the manager understands how the portfolio is likely to respond. If necessary, appropriate adjustments can then be made within the portfolio (in terms of regional, sectoral and company exposures) to respond early to important developments and to ensure that the portfolio is a net beneficiary of these changes.

Considering and managing exposures at the portfolio level also enables the manager to selectively retain exposure to certain companies, sectors and regions that may have greater vulnerability to climate-related impacts or be less able to abate them, but which nevertheless present significant investment opportunities – provided this is offset elsewhere in the portfolio – and that the aggregate exposures are appropriately aligned to deliver the requisite decarbonisation and climate alignment. The concept of a climate 'budget' and overall trajectory for a fund (aligned to a desired climate outcome) is a helpful one because it allows a manager to take attractive investment opportunities that may present themselves across sectors and regions but to manage the overall exposure at the portfolio level to ensure that risks are well managed and the desired climate objective is achieved.

Indeed, there is a space for client outcomes that are specifically targeted towards particular climate outcomes (point two above), as well as those that aim to help finance and deliver the climate transition in a more general and less measured way. The climate-scenario work described in this paper can allow us to see not only a portfolio's current footprint and climate value at risk, but also (with some future planned development) to take a forward-looking view of a portfolio's emissions and intensity under different scenario pathways and to adjust these to target particular climate objectives. We will be providing more detail on such approaches in due course.

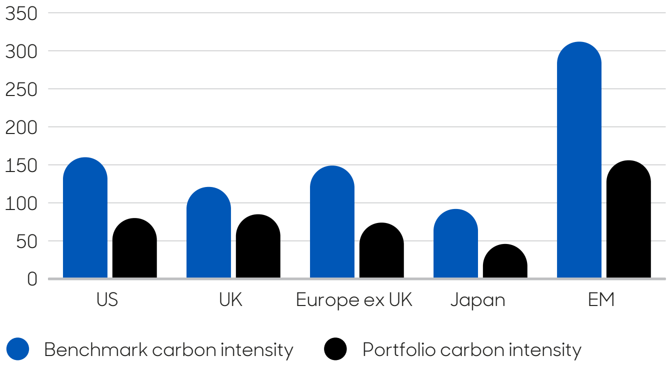
The remainder of this section is focused on the development of climate-driven client solutions that not only deliver financial outcomes, but also contribute towards meeting the goals of the Paris Agreement. This is a strategic priority for abrdn and is already in progress across different asset classes.

Developing and using climate-tilted benchmarks – is there a price to pay?

One good example of climate-focused strategy is the climate-tilted benchmark. Most investors gain exposure to equities and other asset classes using standard benchmarks like MSCI World or FTSE 100. These indices may either be tracked by passive index funds or used as the benchmark for active managers. To manage climate risk or move to net-zero portfolios, one important method that investors are exploring is to replace these benchmarks with low-carbon, high-climate-solution alternatives.

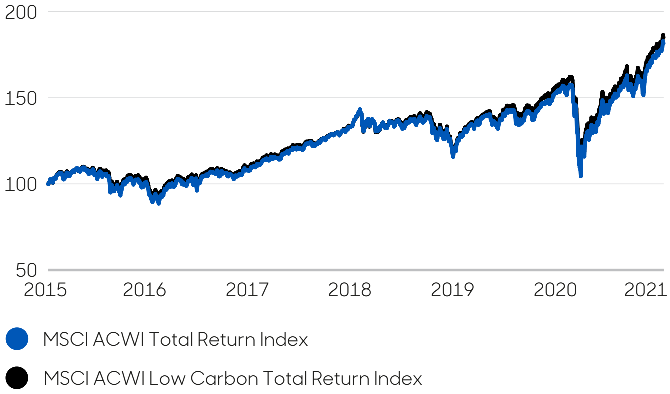
When making this switch, investors generally aim to ensure that climate-tilted benchmarks demonstrate similar financial characteristics to their standard equivalents. To do this, we employ portfolio-optimisation tools that use historical security-level returns and correlation data to generate portfolios with low deviation in returns, or 'tracking error', relative to the standard index, but with substantial improvements to carbon performance.

Figure 34: Reducing portfolio carbon intensity by 50% can be achieved within a 0.5% tracking-error budget



Source: abrdn, September 2020. Scope 1&2 CO2 emissions tonnes/$m revenue.

Figure 35: MSCI low-carbon equity index has closely tracked standard MSCI Equity Index



Source: Bloomberg, MSCI, Jan 2021.

We have found that it is possible to achieve large tilts away from carbon-intensive companies towards climate-transition leaders (as measured by SBTI) and climate solutions while maintaining very similar sector exposures and within a tracking-error budget of 50 basis points (bps).

As Figure 34 shows, for most regions a 50% reduction in carbon emissions and a similar increase in climate-solution exposure is compatible with a small 0.5% tracking error to the market benchmark.

These portfolios also have very similar financial characteristics in terms of risk and valuation multiples. As Figure 35 shows, the historical performance this kind of approach has delivered is as expected. Returns have been very close to the parent index as a low tracking error would suggest.

However, investors considering a switch to these climate-enhanced indices are interested in the future as well as the past. Although the deviation between the benchmark and the climate-tilted index is small in each year, it is not inconceivable that these deviations could accumulate on one side or the other. Climate scenarios are helpful for considering whether climate-enhanced indices are likely to underperform or outperform their benchmarks.

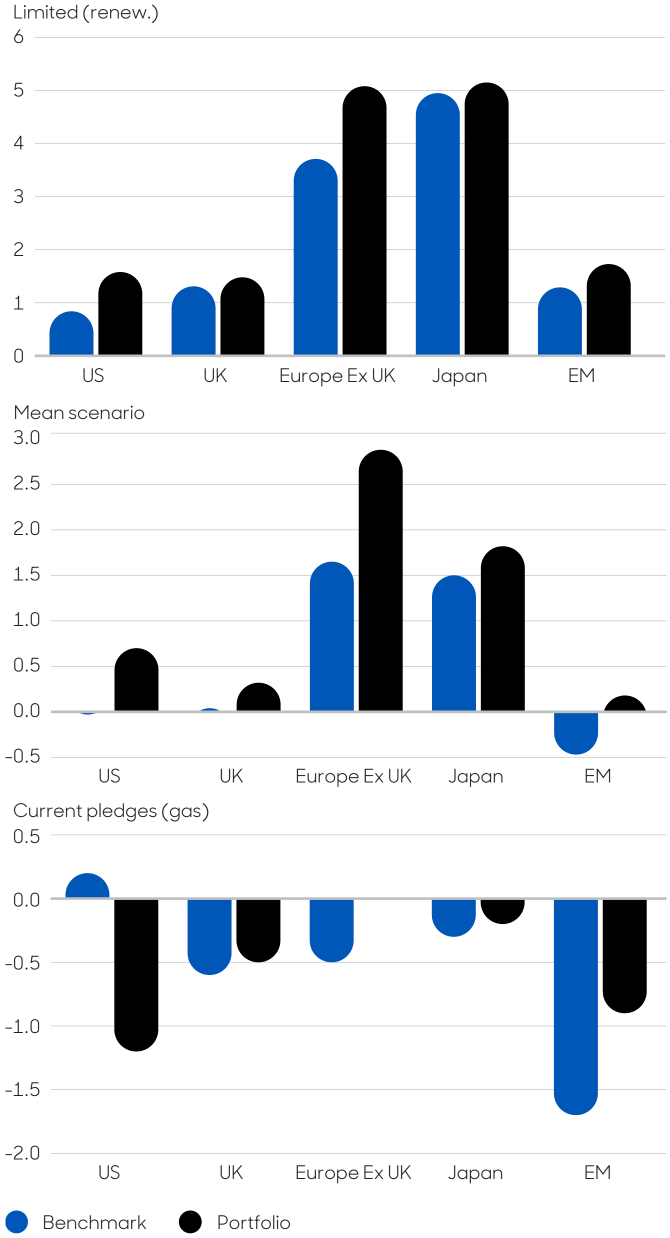
We have run all 14 abrdn climate scenarios for each regional equity index. This approach gave us 70 results (14 scenarios x 5 equity regions). In 59 out of 70 cases (85%) the climate-enhanced index outperformed its benchmark. This was also true in the probability-weighted mean scenario (Figure 36). Paris-aligned portfolios underperform their benchmarks only in scenarios where governments make no further efforts to strengthen climate policy or where they move backwards from current commitments. Even then, the underperformance is small.

The difference between Paris-aligned portfolios and benchmarks is never very large (+0.8% on average, with a range of -2.6% to +3.4% total impact (equivalent to 20-30bps on annualised returns). This small impact is intended: abrdn designed the tilted portfolios to have a very low tracking error to their benchmark.

But the key message is that, on the basis of our 2020 climate scenarios, climate-enhanced benchmarks can be expected to outperform standard equivalents in the mean climate scenario and across most of the climate-probability distribution. This helps reassure investment committees that a switch to these benchmarks is currently sensible.

This result may not always hold true – as indicated above, if governments fail to implement their current commitments, or if there is a 'green bubble' pushing prices of clean-technology stocks or tech stocks that are overweighted in low-carbon indices far above fair value (see below). If this were to occur, investors might have to adjust climate-aligned benchmarks to reduce their climate ambition or to focus tilts on the remaining positive-return opportunities (i.e. the climate-solution dots that remain on the right-hand side of the scatterplot chart). We intend to repeat this exercise annually and re-evaluate the impact of results.

Figure 36: Valuation impairment for regional equity indices under scenarios



Source: Planetrics and abrdn analytics, January 2021. Charts show valuation impact compared to baseline under three climate scenarios. In each case, impairment is provided for five regional equity benchmark indices and their climate-tilted variants.

Developing climate-enhanced products to support the transition

Another way that many investors are adjusting portfolios to increase their climate resilience or align portfolios with net-zero goals is to make allocations to assets focused on climate solutions and climate-transition leaders. Investment teams across abrdn are developing a range of climate-driven products to support the energy transition and meet investors' climate goals. This includes a multi-asset climate fund, a global equities climate and environment fund and a credit climate-transition bond fund.

These vehicles are composed of the companies represented by dots on the more extreme right-hand side of Figure 37, the kind of renewable-energy, electric-vehicle, battery-technology and raw-material companies that will be the winners in the climate transition, as well as of companies that appear to be negatively affected in a much lower-carbon world but which we believe are credible transition leaders.

As indicated in the previous section, scenarios with high expected growth rates and persistently low interest rates provide a benign environment for these companies. As Figure 38 indicates, they have delivered exceptionally good share-price performance in recent years, outstripping global equities by a significant margin.

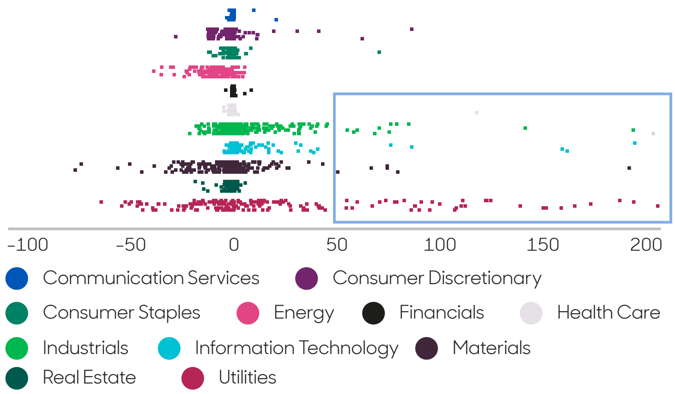
But will this excellent recent performance continue? Is all the good news about climate change already 'in the price'? Our climate-scenario tool provides a useful test for valuations of these companies, stress-testing their performance across the range of scenarios and in our probability-weighted mean.

To test this, we built a portfolio of companies that derived over 50% of their revenues from climate solutions. We then explored how this portfolio would perform across the range of abrdn climate scenarios. We found positive valuation scores in nearly all scenarios. Only in the most climate-pessimistic scenarios using the Message-Globiom model did this portfolio have a negative valuation impairment. In most scenarios and in our scenario mean (see Chart 39), the valuation was strongly positive.

As with climate-enhanced indices, this positive outcome may not always hold. If prices in this segment were to rise another 30% this year, for example, then the mis-valuation identified by the mean scenario would be erased. The same would be true if a green bubble were to inflate in the longer term. Similarly, if the probability of a reversal of climate-policy ambition were to increase, this too might suggest poor returns ahead. But for now, climate scenarios tell a strongly positive story about this segment.

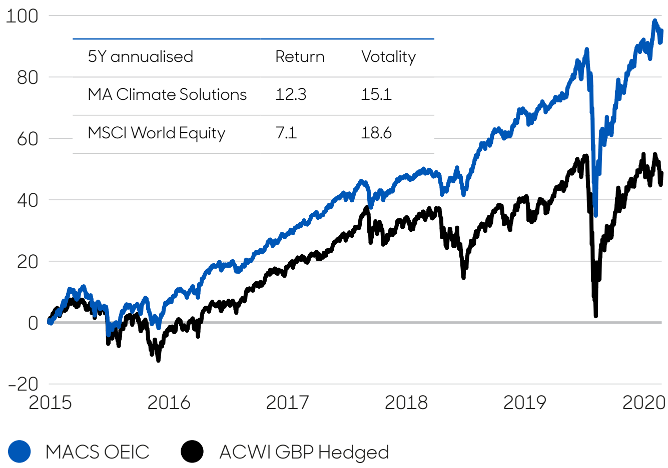
As this case study has shown, climate scenarios provide very useful inputs to the SAA process and the development of climate-enhanced solutions. They have confirmed our view that the climate transition is likely to have very limited impacts on aggregate equity and credit indices. But the large dispersion of impact across and within sectors means that strategies that specifically aim to have long positions in the climate winners and short positions in climate losers (like a climate-tilted benchmark) are likely to outperform on current prices. This is an important conclusion for institutional investors considering the adoption of more climate-aligned investment strategies.

Figure 37: Valuation impact of mean climate scenario on companies in MSCI World Index



Source: Planetrics and abrdn analytics. Outliers beyond 200% are not shown, January 2021. Total impact on valuation (each dot is one company)

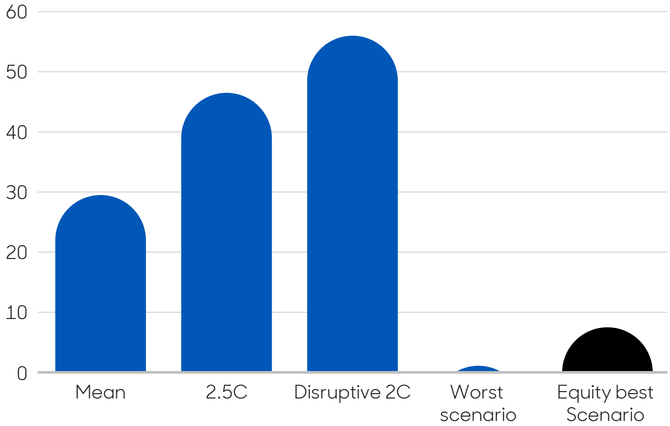
Figure 38: Historical performance basket of climate-solutions securities held in abrdn's multi-asset climate fund model portfolio



5Y annualised	Return	Votality
MA Climate Solutions	12.3	15.1
MSCI World Equity	7.1	18.6

Source: abrdn, November 2020. Chart shows simulated investment performance of climate-solutions model portfolio vs MSCI ACWI equity index, expressed in GBP, currencies hedged.

Figure 39: Performance of climate-solutions equity portfolio in selected scenarios, with standard regional equity for comparison



Source: Planetrics and abrdn analytics, January 2021. Chart shows the valuation impact compared to baseline under a selection of climate scenarios for model climate-solutions portfolio. The best-performing regional equity index across all scenarios is provided for reference.

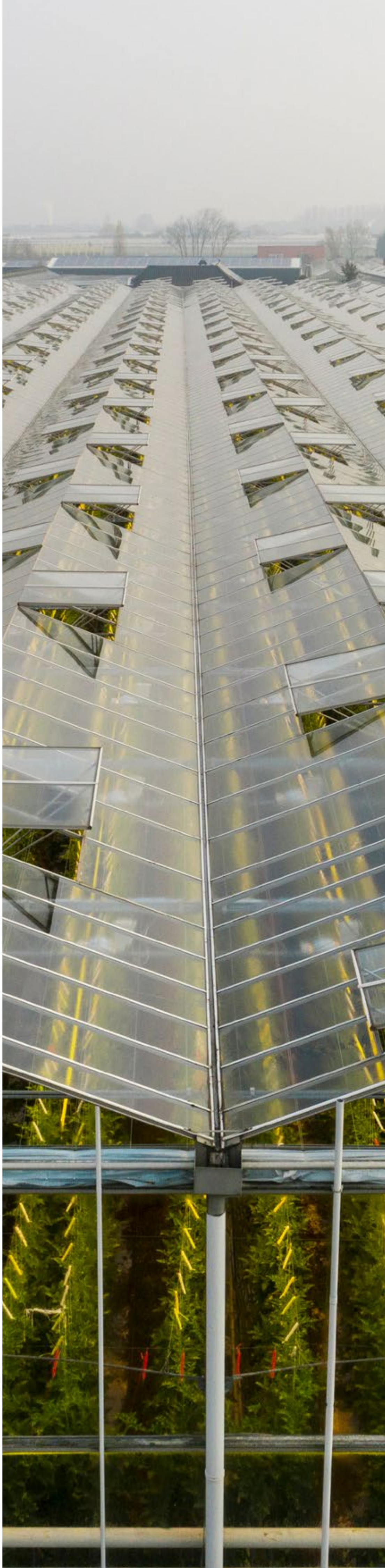
Using climate scenarios to align investment strategies with 2050 net-zero goals

The above discussion shows that we can use climate scenarios to test the investment implications of adopting climate-tilted benchmarks and climate solutions as part of 2050 net-zero strategies. But there are other ways that climate scenarios can be useful in implementing 2050 net-zero objectives for portfolios.

One particular challenge for 2050 net-zero investors is setting intermediate goals. It is easy to say that by 2050, portfolio carbon emissions should be at or close to zero. It is much harder to say where they should be, or can realistically be, by 2025, 2030, 2040, etc.

Climate scenario tools can help identify the kind of changes to emissions that are likely to arise from existing climate policies in various regions. For example, they can be used to show differences in trends in emissions in different sectors and regions. This can be mapped onto portfolio exposures and used to project the baseline trend in emissions, together with the steeper glidepaths achieved by climate-enhanced benchmarks and funds.

We expect this data to be a useful input for modelling how various different strategies may combine to move portfolios towards 2050 net-zero goals and, as a result, to establish realistic levels for intermediate targets. More detail on our approach to delivering our clients' net-zero ambitions through active portfolio management will be published in due course.



Conclusion

Climate scenario analysis is an essential activity for climate-driven asset managers. It is vital that investors understand how physical climate change and the energy transition affect the investment returns of the companies and markets they invest in. And by doing so, we can build more resilient portfolios and generate better long-term returns for clients.

abrdn's unique approach to climate-scenario analysis sets us apart from other asset managers. Bespoke scenario construction, the integration of macro and micro drivers of climate impacts, and the use of probabilistic assessments all allow us to generate unique insights into the asset-price implications of the different dimensions of climate change.

A key finding from our analysis is that the transition to a net-zero-carbon global economy is highly likely to continue, but probably not in time to meet the goals of the Paris Agreement. The non-renewable energy share in the global energy mix declines from 68% today to 27% by 2050 under our mean scenario and even more in Paris-aligned scenarios. That said, the transition will not be evenly distributed across sectors and geographies. The power sector is most likely to decarbonise on Paris-aligned timeframes, and, geographically, Europe has the highest probability of completing the low-carbon energy transition.

From a technology perspective, solar PV is likely the biggest winner from the energy transition, and coal the biggest loser. Oil demand is expected to peak in the early 2030s before trailing off as the share of electric vehicles crosses critical thresholds. Natural gas is likely to have a larger long-term role to play in the energy mix, though that does depend heavily on the extent to which the relative cost of renewable technologies continues to fall rapidly and whether carbon-capture and storage technologies become more cost-competitive over time.

Despite these transformational changes in energy usage, the long-term aggregate impact for listed equity and credit indices is likely to be modest. However, impacts on market pricing may not occur smoothly, and modest aggregate effects may mask much larger changes as we drill down into more granular impacts. At the sector level, global utilities are likely to be the largest winner and fossil-fuel energy the largest loser. But even within these sectors, there is likely to be very large dispersion across sub-sectors, firms and regions.

For example, renewable-energy-based utilities significantly outperform coal utilities; copper and lithium miners do much better than coal miners; and oil-equipment manufacturers lose out to battery, wind-turbine and solar-panel manufacturers. This implies an enormous opportunity to draw on climate-scenario analysis to add alpha to actively managed investment portfolios. Ultimately, climate risk and opportunity is mostly a micro and stock-specific phenomenon.

The insights from our innovative analysis are being embedded in our business strategy, in the key stages of our investment process and in the development of climate-driven solutions to deliver superior outcomes for our clients. Our scenario analysis will feed into bottom-up investment decisions, complement our broader company research and form a critical component of our approach to stewardship. This will allow us to form stronger assessments of the credibility of firms' transition strategies and lead to allocation changes where we think that risks are not being well managed.

We are also fully integrating climate risk and opportunity into our SAA framework, with our probability-weighted mean approach particularly valuable for improving mean-variance optimisation. More generally, we are developing a wide range of innovative climate-change (including net-zero) solutions for our clients. These include climate-tilted benchmarks and climate-enhanced products that focus on climate solutions and transition leaders, as well as having real-world impacts on decarbonisation. In many cases, we demonstrate that these climate solutions can outperform standard benchmarks and products.

The insights presented in this paper are only the beginning of our climate-scenario journey. We will repeat our analysis on an annual basis, taking into account the influence of changes in policy, technology and the structure of markets. We will expand our analysis into the full range of private assets and undertake more granular dives into the drivers of change within sectors like energy and utilities. We will be working to incorporate dynamic business change into our analysis, improving our ability to identify successful transition companies.

We will also be enriching our analysis of physical climate risk by increasing the number of scenarios, allowing for physical tipping points to occur at lower levels of temperature change, expanding the range of assets subject to physical damages and exploring the important issue of climate adaptation in depth. We will publish our insights in a follow-up paper in late 2021, including a more comprehensive treatment of real estate and infrastructure assets than was possible in this paper.

"The transition to a net-zero-carbon global economy is highly likely to continue, but probably not in time to meet the goals of the Paris Agreement."

For more information visit abrdn.com

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