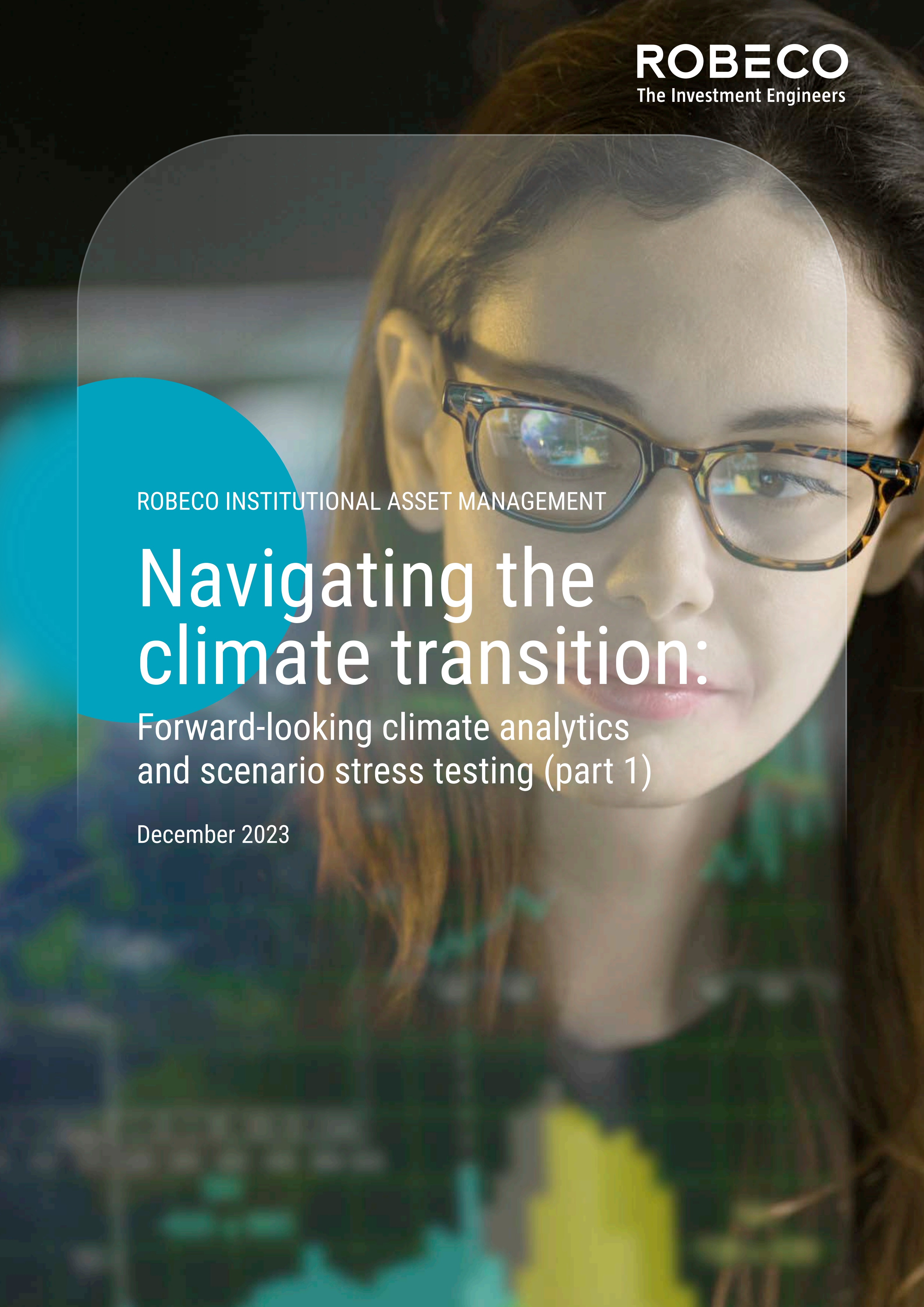

ROBECO
The Investment Engineers

ROBECO INSTITUTIONAL ASSET MANAGEMENT

Navigating the climate transition:

Forward-looking climate analytics and scenario stress testing (part 1)

December 2023

Navigating the climate transition

Part 1: Forward-looking climate analytics

Foreword

There is robust scientific evidence that the global climate has been changing due to human activity, primarily through the usage of fossil fuels and land-use changes. Global warming, if unmitigated, will have unacceptable impacts on society and the global economy. It is clear that society has to act now, as the costs and impact of inaction increase by the year.

Robeco acknowledges the responsibility of the asset management industry to manage climate change risks, opportunities and impacts. Climate change poses material risks and opportunities for our clients' investment portfolios, and it is our fiduciary duty to identify and manage these. Working in partnership with our clients, Robeco aspires to take a leading role in contributing towards a net zero economy. We firmly believe this will create opportunities to enhance long-term risk-adjusted returns.

As investment engineers, Robeco seeks to continuously innovate its investment approach, integrating new research and data as it becomes available. This holds true in particular for climate analytics. To navigate the transition to net zero by 2050, we need forward-looking models to help make well-informed investment decisions which incorporate not only historical performance but also transition plans, risks and opportunities.

Robeco has invested significant resources in developing forward-looking climate analytics to help guide our investment decisions. These include a climate traffic light for assessing how well a company aligns with the well-below-2-degree transition pathway in its industry; a climate solutions score to measure a company's contribution to economy-wide decarbonization; and a climate score to measure a company's overall impact on climate change and its mitigation. This Part 1 document explains these different metrics and how they complement each other for making a comprehensive assessment of climate transition risks, opportunities and impacts.

In Part 2, published separately, we outline our approach to climate scenario stress-testing and we share our insights into the implications for different sectors and asset classes.

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For more information on our approach to climate change for countries please see our Country Sustainability Ranking and Country Sustainability Development Goals (SDG) frameworks.

Contents

1. Introduction

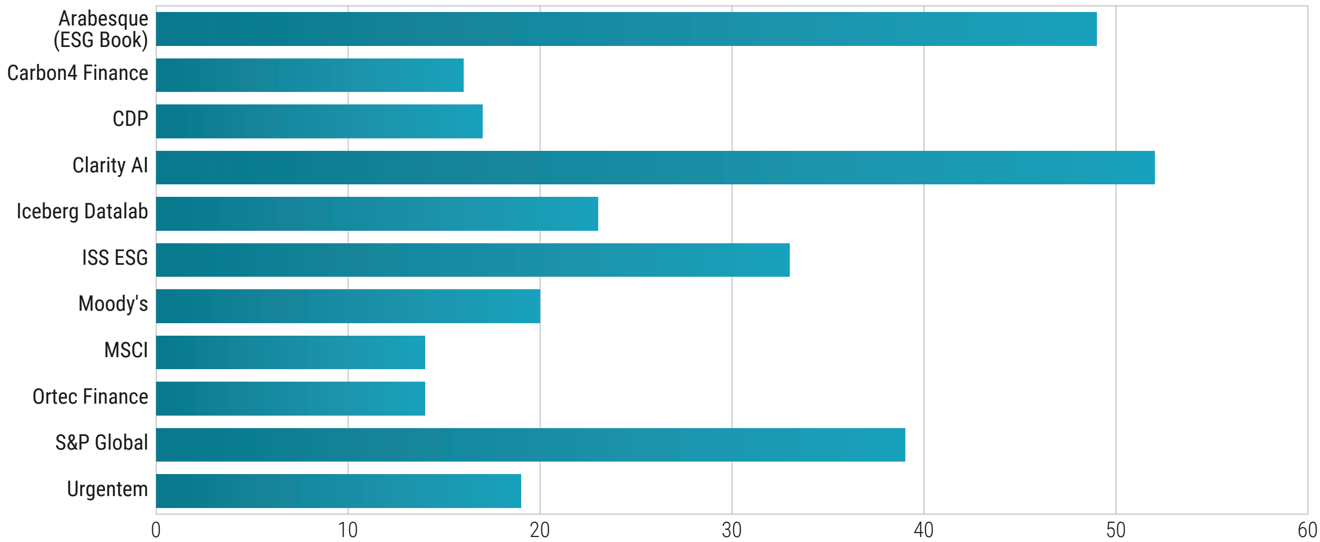
The impacts of climate change are already being felt today. 2023 saw another year of significant economic losses from extreme weather events[1]. Consequently, there has been an increase in the number of policies relating to climate change[2]. It is critical as an asset manager to understand our exposure to these risks and climate data and analytics are key to this.

When it comes to climate analytics, much of the available data is backward-looking. Indeed, carbon emissions data, for example, is often lagging by one to two years. To successfully navigate the future, however, it is essential to have reliable and science-based forward-looking climate analytics. This is important because the future may look very different from the past, both in terms of global temperatures and global policies designed to address climate change. We need to understand how companies and countries look ahead to manage this shift.

Forward-looking climate analytics are still in their infancy. The underlying models are complex and continue to evolve, hence their outputs are uncertain and volatile. For example, the Institutional Investors Group on Climate Change (IIGCC) data catalogue for investors showed significant divergence across data providers in their assessment of how well companies align with the Paris Agreement (Figure 1)[3].

Robeco uses forward-looking climate analytics to make better informed investment decisions on behalf of our clients. At any time, we must be able to explain to clients how we incorporate climate factors in our investment decisions and why. For this reason, we cannot take the climate metrics from third-parties at face value, so we have carefully reviewed the underlying assumptions, methodologies and data used in climate analytics from a dozen data providers. Following this review, we developed a Robeco approach to climate analytics outlined in this paper.

Figure 1 | Significant variation between providers' assessment of alignment
% of companies rated 2ºC or less/considered aligned or aligning



Source: IIGCC, dummy portfolio of 57 companies. Percentage of companies considered "aligned" or "aligning" – based on authors' assumptions and definitions.

1. National Centers for Environmental Information: National Oceanic and Atmospheric Administration
2. The Climate Action Monitor 2022 (oecd.org)
3. IIGCC launches data vendor catalogue for investors – IIGCC

2. Robeco's approach to climate change analysis

2.1 Double materiality

Robeco looks at climate change through the lens of double materiality (see Figure 2):

- On the one hand, we need to manage the risk that climate change poses to our investments, i.e. the financial impact of climate change. To do this we ask key questions such as: how much will it cost for a company to decarbonise its operations and supply chain? What physical risks and policy risks is the company exposed to and how will this impact valuations? And finally, which companies are set to benefit from the low-carbon transition through increased revenues for low-carbon products?

- On the other hand, given our net zero commitment, we need to understand the climate impact of our investee companies and countries. In this instance the key questions we ask are: How much is the company currently contributing to climate change? Is the company providing any solutions to the climate change crisis? What plans does the company have to reduce its emissions? And how ambitious and credible are these?

To answer these questions, we require robust knowledge of how the net zero transition is likely to play out across different sectors of the economy, and how this affects the decarbonization strategies, costs, risks and opportunities for companies. This is the focus of Robeco's sector decarbonization pathway research, an in-house research program conducted by the industry experts in our SI Research Team.

2.2 Sector decarbonization pathways

For each sector, our SI Research analysts identify the following:

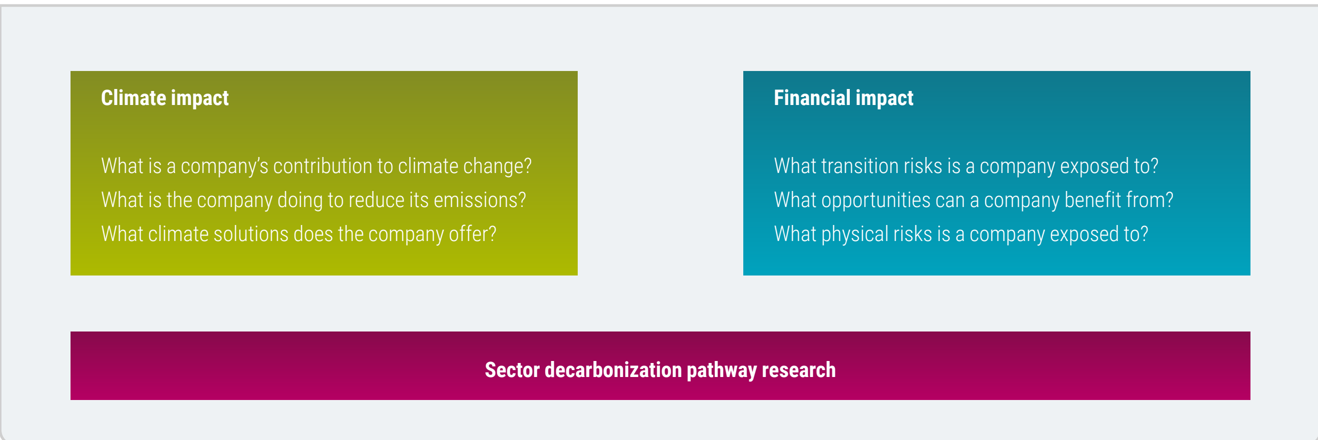
1. The remaining carbon budget allocated to that sector in science-based transition scenarios to achieve well below two degrees global warming
2. The required and most likely pathway to reduce sectoral emissions and remain within the carbon budget, based on available technologies and their cost and maturity
3. The expected total production change for the sector (demand growth or destruction)
4. The GHG emissions scopes that are most material and that the sector can be held accountable for (Scopes 1, 2 and/or 3)

Based on this, a sector decarbonization pathway is derived using the most relevant emissions intensity metric (tCO_2/unit of production or revenue). The pathway indicates how much the emission intensity of a product, such as steel or cement, should decline over time. In practice, the International Energy Agency (IEA), Transition Pathway Initiative (TPI) and Science-Based Targets Initiative (SBTi) are used as the primary sources for these pathways.

For example, in the automotive sector, the pathway focuses on end use-phase emissions (scope 3 downstream) which represent the largest share of emissions across a vehicle's lifecycle. In order to normalise emissions and make them comparable to the sector benchmark, the unit used is kilometres driven. The metric used for assessing decarbonization in the automotive sector is therefore Scope 3 downstream in gCo_2 per kilometre driven.

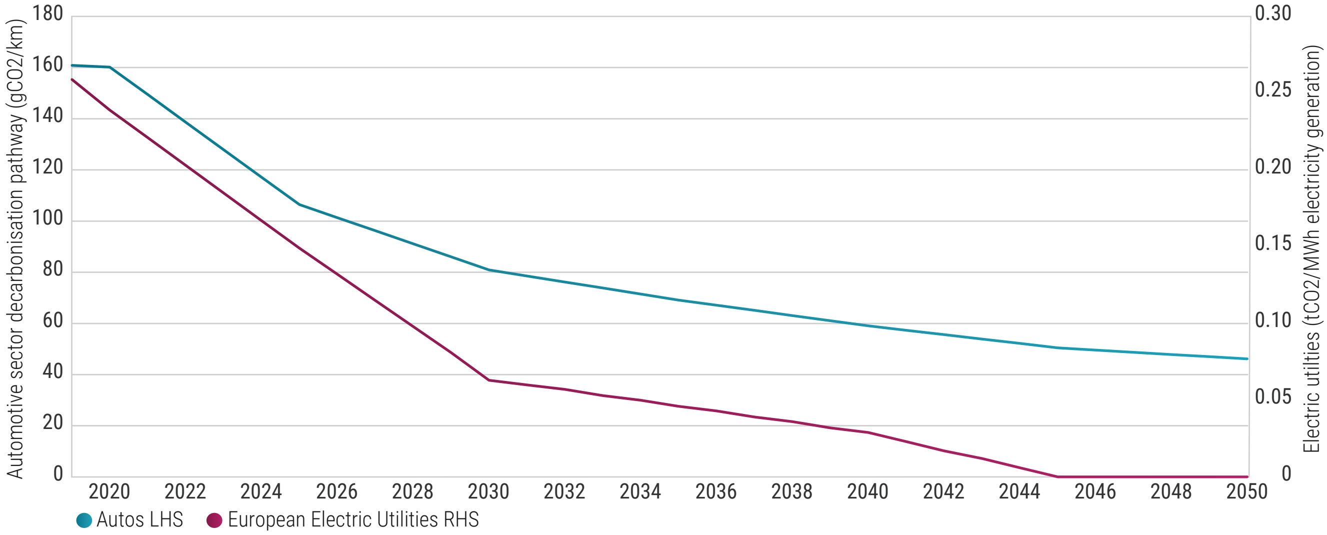
Where available, the sector pathways are also broken down regionally. Currently, this is only available for the power sector, however this is an area of continuous research and we intend to have regionally-adjusted sector pathways in the near future.

Figure 2 | Key investment questions related to the double materiality of climate change



Source: Robeco

Figure 3 | Sectoral pathways for the automotive and European electrical utilities sectors (well below 2 °C)



Source: Transition Pathway Initiative, as at 31st March 2023.

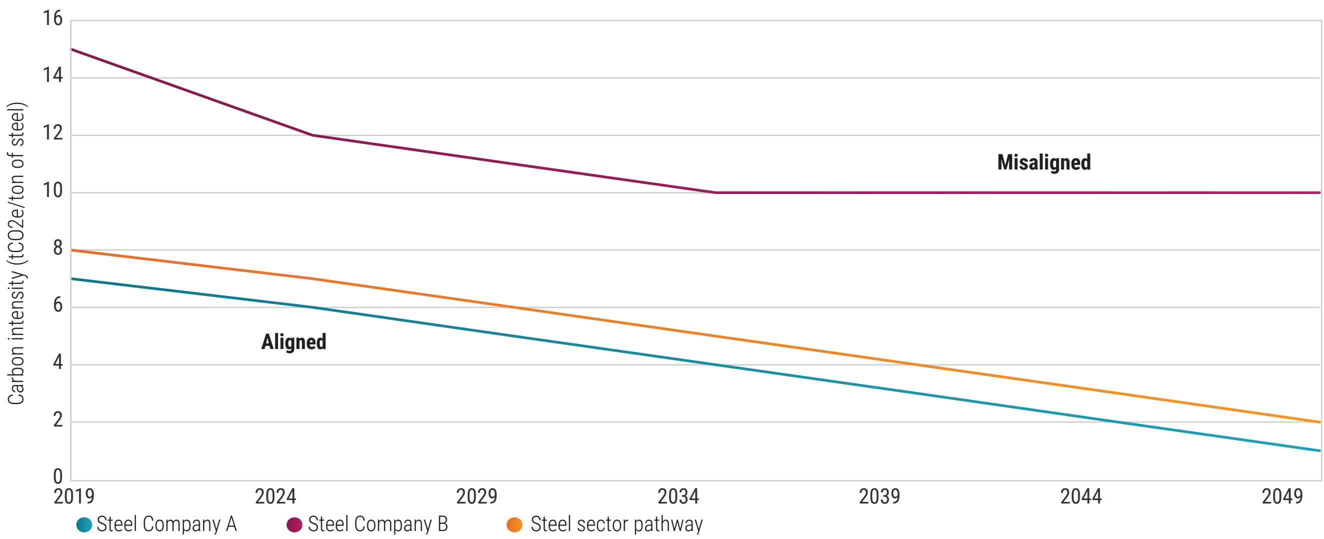
In Figure 3, we show the sectoral pathways for the automotive, and electric utilities sectors.

Based on these pathways, we can assess how ambitious the company's emissions reductions plans are relative to the sector decarbonization pathway. In other words, whether the company is Paris-aligned within its sector.

We measure this by projecting a company's emissions' intensity into the future using the company's emissions reduction targets and then comparing this to the relevant sector decarbonization pathway. The alignment is initially assessed by measuring the distance of the company's pathway from the sector pathway.

For example, in Figure 4 we show the sector decarbonization assessment for two companies in the steel sector. In this illustrative example, Company A's projected emissions (blue) are below the sector pathway line (orange) and therefore aligned. Company B's projected emissions (rose) are significantly above the sector pathway line and therefore misaligned.

Figure 4 | Sector decarbonization pathway alignment in the steel sector



Source: Robeco, for illustrative purposes only.

Following this, we assess the financial implications of a company's decarbonization pathway. We calculate how much the company will need to spend to reach its targets, how much is needed to align with the sector pathway, and how that compares to the company's stated capex plans. In order to achieve this, it is necessary to have a clear understanding of the technologies available to decarbonize a company's operations and supply chain within a given sector, how much those technologies will cost and how much capacity for decarbonization each has. We share more details on this analysis in section 4.1.1.

In the following sections, we will delve further into how we use this research in our forward-looking analytics on climate impact (section 3) and on financial impact (section 4).

3. Climate impact

Building on the sector pathway research, we develop forward-looking analytics to evaluate how companies are both contributing to and mitigating climate change, in other words their 'climate impact.' Our headline metric for this is the Robeco Climate Score, which gives positive scores to climate leaders and negative scores to climate laggards (using a range from -3 to +3).

3.1 Climate Score

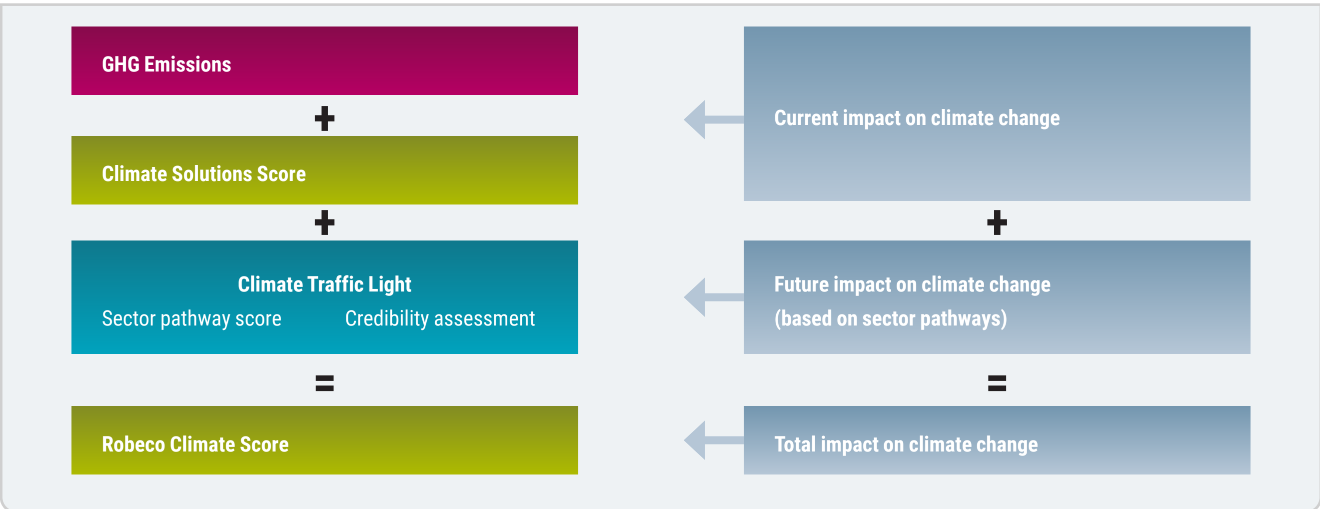
The primary impact a company has on climate change is measured by the carbon emissions it produces. These emissions tend to be sector dependent and do not paint a full picture of climate impact. Often, the sectors which have the most emissions are providing a critical function to the global economy, for example steel and cement, and therefore cannot simply stop their emission-intensive processes. In these cases, how the company plans to reduce their emissions is equally important. Furthermore, there are other companies that are emitting carbon to produce technologies and solutions which are crucial for the decarbonization of the whole economy, an example of this is batteries produced for energy storage. These companies should be recognized for their positive contribution to climate change mitigation.

Based on this reasoning, the Climate Score is composed of three elements, as shown in Figure 5:

1. GHG Emissions: a company's current carbon footprint
2. Climate Solutions Score: a company's contribution to climate solutions
3. Climate Traffic Light: a company's GHG reduction targets and the credibility of these targets, i.e. the Paris Alignment of a company

The combination of backward-looking and forward-looking elements means that companies that currently have very high carbon footprints can only receive a neutral score if they have strong and credible targets, otherwise they will receive a negative score. If these companies increase their share of green revenue from climate solutions, they could achieve low positive scores. Companies with low emissions generally have a lower impact on climate change unless they are providing a specific climate solution. For this reason, scores for those companies range from -1 to +1. Only climate solutions providers are able to achieve the highest climate scores, provided they have a good decarbonization plan for their own operations. This is because the solutions they provide are likely to enable greater decarbonization across the whole economy. Figure 6 provides a description for each climate score and examples for each of the aforementioned archetypes.

Figure 5 | The Robeco Climate Score is composed of current and forward-looking elements



Source: Robeco, for illustrative purposes only.

Figure 6 | Climate score descriptors

Company profile[5]/Climate score outcome	-3	-2	-1	0	+1	+2	+3	Company examples
High/Medium emitter, bad targets	■	■						Energy company with no targets
High/Medium emitter, good targets			■	■	■			Steel company installing electric arc furnaces to reduce emissions
Low emitter, bad targets			■					Healthcare company with no energy efficiency targets
Low emitter, neutral/good targets				■	■			Data centre planning to use renewable energy for all its centres
Solutions provider, bad targets				■	■			Wind turbine manufacturer with no plans to use low-carbon steel
Solutions provider, good targets						■	■	Battery manufacturer with plans for battery recycling

Source: Robeco, for illustrative purposes only.

The climate score is a rules-based score constructed initially using external data sources. As much of this external data is in its infancy and often comes with a time lag, our analysts are able to enhance the inputs by drawing on their knowledge of the company.

In the next few sections we explain the underlying components of the climate score. Whereas the climate score is useful in summing up our assessment of the company climate impact in a single number, the underlying components are equally informative and useful for different aspects of our investment and stewardship processes.

3.2. GHG Emissions

This component captures the current (in most cases negative) impact a company has on climate change. Here we look at the carbon footprint (tCO2/$EVIC) of companies, based on data from Bloomberg. We measure production phase emissions (Scope 1, 2 and 3 upstream) as a basis for all sectors. For sectors where Scope 3 downstream is most material and where companies have the highest level of complicity with the end emissions, we also include Scope 3 downstream. These are sectors where we deem that companies are able to significantly influence their downstream emissions. The full list is shown in Table 1.

Table 1 | Sectors for which we include Scope 3 downstream emissions in the climate score

Aerospace & Defence
Agricultural & Farm Machinery
Automobile manufacturers
Beverages
Building products
Construction Machinery & Heavy Transportation
Energy
Financials
Gas and Multi-Utilities
Mining
Real Estate

We assign thresholds to determine what qualifies as a very high/high/medium/low emitter and give an overall GHG emissions score on this basis, as shown in Table 2. The thresholds are based on an analysis of sectoral footprints as well as an assessment of relative contribution to global emissions. For example, within our investment universe, companies with emissions >3000 represent approximately 55% of total carbon emissions, whereas those with <300 represent less than 10% of total carbon emissions, despite representing 80% of the total enterprise value.

5. High/medium/low emitters determined based on the carbon footprint (EVIC) of a company. >1000 is high, <300 is low.
Good targets are determined by an assessment of the ambition of the target relative to the sector pathway & the credibility of those targets.

Table 2 | GHG emissions score based on issuer carbon footprint

Carbon footprint (tCO2e/EVIC)	GHG emissions score	Emitter type
>3000	-3	Very high
1000-3000	-2	High
300-1000	-1	Medium
10-300	0	Low
<10	0	Very low

In addition to carbon footprint, we also look at revenues from thermal coal extraction, generation and supporting products and services because of the strong scientific and policy consensus on the need for near-term phase-out of thermal coal. We assign a -3 score to companies with revenues from thermal coal greater than 10%, in line with the threshold set in Robeco's Sustainable Development Goals (SDG) framework[6].

3.3 Climate Solutions Score

Achieving a successful decarbonization of the economy requires not only a focus on reducing emissions, but also significant investments in low-carbon solutions. The Climate Solutions Score aims to reward companies who are already investing and generating revenues from such climate solutions.

There are several ways to determine what constitutes a climate solution. The IPCC[7] and IEA[8] both provide lists of which technologies, activities and services can substantially contribute to mitigating climate change and thus constitute climate solutions. The EU taxonomy identifies activities which it sees as contributing significantly to climate change mitigation and adaptation, both of which can be considered climate solutions. This is used by the IIGCC in their latest standard to identify climate solutions[9]. Most recently, the GFANZ has defined climate solutions as "Technologies, services, tools or social and behavioral changes that directly contribute to the elimination, removal, or reduction of real-economy GHG emissions or that directly support the expansion of these solutions"[10].

The Robeco SDG framework also identifies products and services which can be considered climate solutions based on their contribution to the climate-relevant sub-targets of the UN SDGs. This is based on sector knowledge and academic research. Examples of such activities include the manufacturing of batteries, power generation from renewables and manufacturing of electric vehicles.

Given the well-established nature of the Robeco SDG framework, we use it as a starting point for our definition of climate solutions, focusing on activities that contribute to the relevant targets of the internally developed SDG Framework, including sub-targets from SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action). We will also consider activities that are eligible for climate mitigation objectives under the EU Taxonomy or other relevant (legislative and scientific) standards.

The Climate Solutions Score is then determined based on the % revenues a company receives from these climate solutions. Specific thresholds are used to assign scores to the positive contributions of a product based on the level of maturity of an activity. For example, the threshold for revenues from electric vehicle sales would be lower than the threshold from renewable energy generation. The thresholds will be ratcheted up over time as the net zero transition unfolds.

Table 3 provides some examples of activities that are considered climate solutions and the associated threshold for a given sector.

Table 3 | Climate related activities and their revenue thresholds

Sector	Activity	Revenue thresholds & associated climate solutions score
Automotive suppliers	Manufacturing vehicle batteries	19.9% -> +1 29.9% -> +2
Building materials and products excluding cement	Insulation	32.9% -> +2
Energy exploration and production	Wind energy equipment	64.9% -> +1
Metals and mining	Lithium mining	32.9% -> +1 65.9% -> +2
Utilities	Renewable energy generation	32.9% -> +1 65.9 -> +2

6. Robeco SDG framework Explanation
7. Climate Change 2022, Mitigation of Climate Change. Summary for Policymakers (ipcc.ch)
8. ETP Clean Energy Technology Guide – Data Tools - IEA)
9. IIGCC Climate Solutions Guidance
10. GFANZ Transition Finance and Real Economy Decarbonisation December 2023

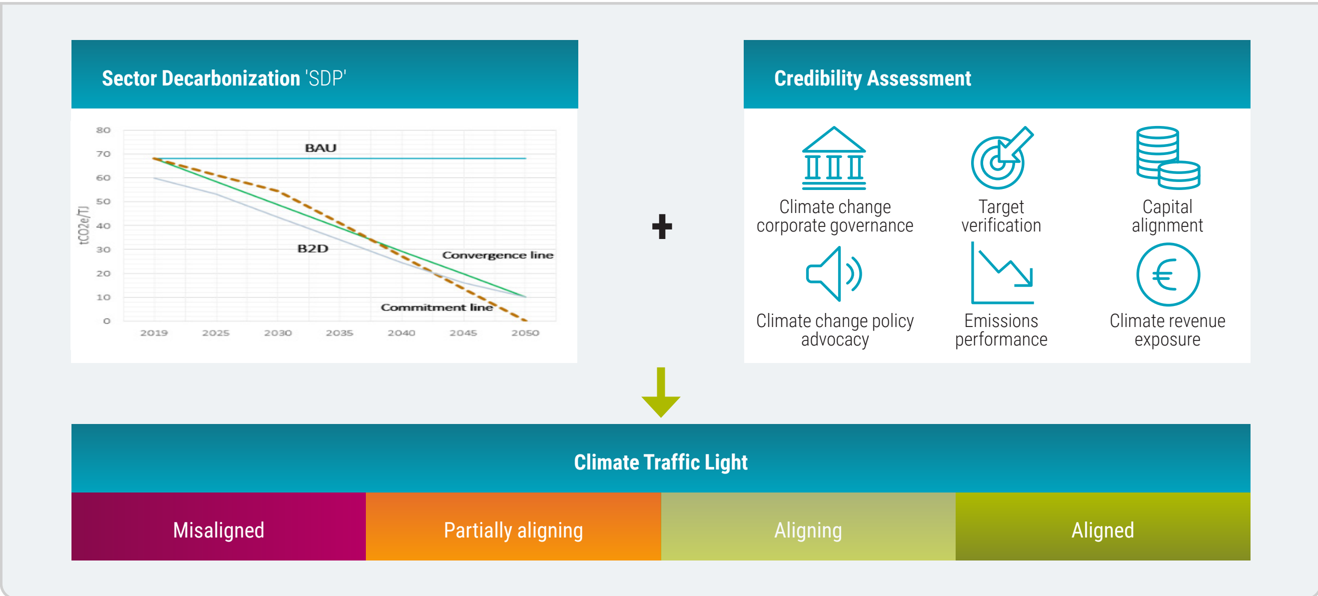
3.4 Climate Traffic Light

This component assesses the future impact of a company on climate change by answering two questions:

1. Are the company's projected emissions in line with its required sector decarbonization pathway under a well below 2°C scenario (regionally adjusted where needed)?
2. Does the company have verified targets and a credible plan for achieving its emission-reduction goals?

Together, the two questions form our overall assessment of a company's Paris Alignment. We visualize this assessment using the Robeco Climate Traffic Light which indicates whether a company is 'aligned', 'aligning' or 'partially aligning' to 'misaligned' with the goals of the Paris Agreement, taking into consideration the "common but differentiated responsibilities" of different nations (see Figure 7).

Figure 7 | Robeco Climate Traffic Light



Source: Robeco. For illustrative purposes only.

The assessment of the first question, whether the company's decarbonization plan is aligned with its sectoral benchmark, is based on the sector pathway research described earlier in this paper (section 2.2). In this step, each company receives a sector decarbonization pathway (SDP) score, from 0 to 100, where 100 is fully aligned and 0 is fully misaligned.

The second question focuses on six aspects that together paint a picture of the credibility of the company's decarbonization plans:

a. Target verification: Does the company have targets and have they been approved by the Science Based Targets initiative?
b. Climate change corporate governance: Does the company's board have oversight of climate change risks and impact? Does the company disclose relevant emissions?
c. Capital alignment: Has the company set out a capital expenditure plan that will enable it to meet its targets?
d. Climate change policy advocacy: Is the company lobbying against climate change policy either directly or through an industry body of which it is part?
e. Climate revenue exposure: Does the company have significant revenues from highly emitting activities that require phasing out under the Paris agreement? Is the company contributing significantly to climate change mitigation through its products and services?
f. Emissions performance: Is the company already showing evidence of decarbonization?

Table 4 | Credibility component weights vary based on their relative importance

Credibility component	High impact sector	Low impact sector
Target verification	30%	40%
Climate change corporate governance	10%	20%
Capital alignment	15%	0%
Climate change policy advocacy	10%	0%
Climate revenue exposure	15%	0%
Emissions performance	20%	40%

Each of the above components are scored from 0 to 100. They are then combined using a weighting table to reflect the level of importance of each component, shown in Table 4. The weights are different for high impact and low impact sectors, as defined by Robeco based on Institutional Investors Group on Climate Change (IIGCC) definition of high impact sectors contained within the Net Zero Investment Framework. Based on this, a credibility assessment score of 0 to 100 is obtained. The SDP score and credibility assessment score are then combined using the matrix approach displayed in Figure 8. This ensures that a company cannot be considered aligned only on the basis of its targets or simply on its excellent governance and disclosure. Both are required to be considered aligned.

Figure 8 | Combining the SDP score and credibility assessment to obtain a final Climate Traffic Light

		Sector decarbonisation pathway score				
		100-80	80-60	60-40	40-20	20-0
Credibility assessment score	100-80	Aligned	Aligning	Aligning	Partially aligning	Misaligned
	80-60	Aligned	Aligning	Partially aligning	Partially aligning	Misaligned
	60-40	Aligning	Partially aligning	Partially aligning	Misaligned	Misaligned
	40-20	Partially aligning	Partially aligning	Misaligned	Misaligned	Misaligned
	20-0	Partially aligning	Misaligned	Misaligned	Misaligned	Misaligned

Source: Robeco. For illustrative purposes only.

In order to be used for the climate score, the Climate Traffic Light is converted into a score which reflects the level of contribution to climate mitigation if emission reductions are successful. For example, high and very high emitters can make a significant contribution to emissions reduction if they establish and achieve ambitious reduction targets. An example would be a steel company that converts to electric arc furnaces for all of their steel production. Figure 9 shows the conversion for high and low emitters.

Figure 9 | Converting the traffic light into a climate score component

Carbon footprint	Climate Traffic Light	Paris Alignment Score
High emitters	Misaligned	-1
	Partially aligning	+1
	Aligning	+2
	Aligned	+3
Low emitters	Misaligned	-1
	Partially aligning	+0
	Aligning	+0
	Aligned	+1

4. Financial impact

The sector pathway research also underpins our forward-looking analysis of the financial transition risks and opportunities that companies face as they decarbonize their businesses. We complement these transition metrics with physical risk data, so that we get an overall assessment of the impact climate change is having on companies.

4.1 Transition risk and opportunities

When we look at transition risk, we assess the financial costs companies face from the need to decarbonise their operations and products as well as which policies will have an impact, such as carbon pricing and fines. We do this fundamentally using a bottom-up sectoral approach, but we also have metrics which allow for a quantitative approach at portfolio-level.

4.1.1 Fundamental approach

Every company will be exposed to different transition risks and opportunities depending on the sector and regions they are active in. We assess this fundamentally by using the sector pathway research. For each sector, the drivers of transition risk and opportunities are assessed by our SI research analysts using the following:

- Capex costs from investment in new infrastructure and technologies to decarbonize operations and end products, for example building a new electric vehicle (EV) production plant
- Opex costs from increased spending needed to decarbonize, for example purchasing batteries for EVs
- Demand destruction or creation from behavioural changes or regulation, for example a drop in oil demand as a result of higher electrification of the economy or an increase in revenues from renewable power generation
- Policy risks from increased taxation or fines as a result of regulatory changes and carbon pricing, for example the cost relating to a company purchasing more carbon credits in the EU as the free allowances are phased out

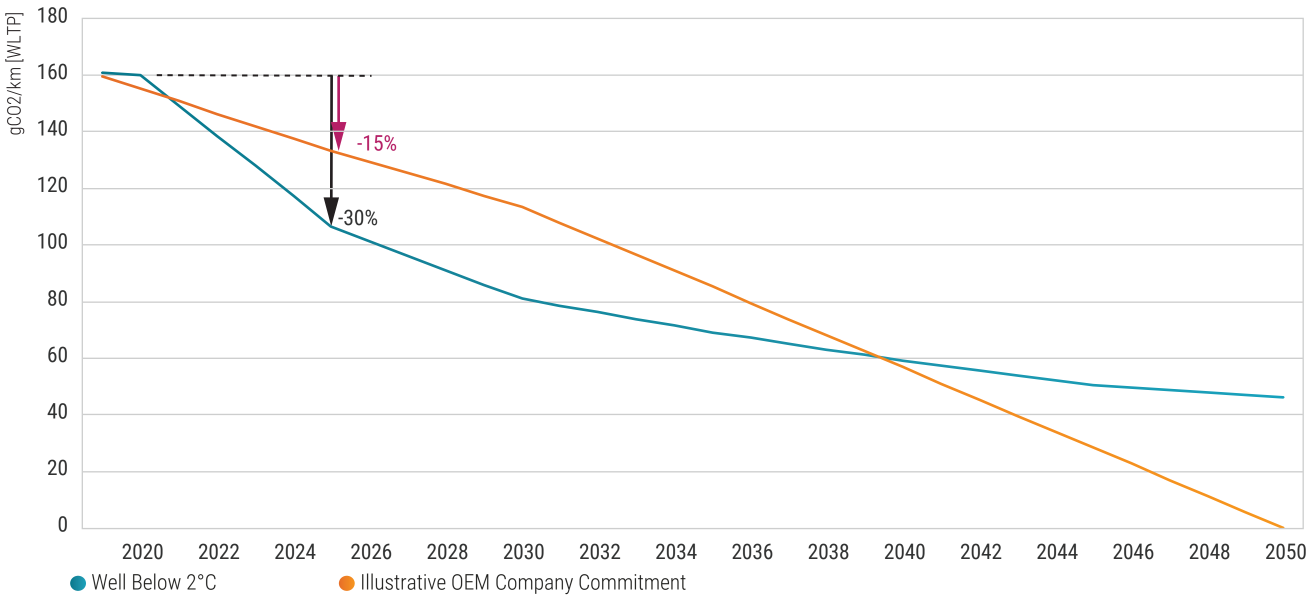
For each of the relevant drivers, on a sector by sector basis, a fundamental model is developed to estimate these costs. This differs depending on the technologies available to decarbonize the sector, and on the expected policy response. This in-depth fundamental assessment gives us a bottom-up view on transition risks and opportunities across the companies in our investment universe.

For example, in the automotive sector, the primary decarbonization technology is EVs. In order to shift production towards more EVs, existing manufacturing plants will need to be converted to EV manufacturing plants or new plants will need to be built. Auto manufacturers also require batteries for their EVs. These can either be sourced contractually, by purchasing them directly from a battery manufacturer, or companies can build their own battery plants independently or as part of a joint venture. Each of these technology options goes along with certain capex and opex costs. For individual companies, we can approximate their overall decarbonization costs by triangulating their emission reduction targets with their technology options.

Take, for example, a company in the automotive sector that has set a 15% reduction target for 2025, (Figure 10), however to be in line with the required sector pathway, they should be decarbonizing by 30%. Based on these targets, we calculate what their auto production mix should be by 2025, and in particular how many EVs will be needed. We can then calculate how many plants and batteries will be required to deliver that number of EVs and this gives us the capex and potentially opex cost the company will incur to achieve their targets or to reach the required sector pathway line. These costs can then be compared to those announced by the company. This gives financial analysts an understanding of whether the company is likely to face higher costs than they anticipate, and whether a company is likely to meet their targets.

For policy and regulatory costs, a regional perspective is needed. For example, currently only auto manufacturers in the EU will incur fines for not meeting certain thresholds of EV sales. This is factored into our fundamental assessment.

Figure 10 | Assessing decarbonization costs



Source: Robeco, Transition Pathway Initiation, for illustrative purposes only

4.1.2 Quantitative approaches

We also use quantitative metrics to assess portfolio level transition risk. These complement our bottom-up fundamental approach. Most quantitative metrics contain noise at company level but give a good directional assessment at portfolio level. Our preference is therefore to use these metrics at portfolio level.

In order to test the performance of a transition risk metric at portfolio level, we apply the following methodology.

We construct portfolios of "clean minus dirty" stocks using the transition metric in question. We then calculate the performance of these portfolios during climate transition events. If the "clean minus dirty" portfolio performs well during these events, we deem the metric to be successful at capturing transition risk. To identify climate transition events, we use both a news-based continuous approach using the Climate Policy Uncertainty Index[11] and a discretionary event approach using our own assessment of what constitutes a transition event. Some examples of transition events include the ratification of the Paris Agreement, the introduction of the EU Climate Law and the announcement of the US Inflation Reduction Act. Using this methodology alongside a qualitative judgment, we evaluate several quantitative transition metrics including MSCI transition Climate Value at Risk (MSCI CVaR) and our proprietary metric climate beta.

Our preferred metric for measuring transition risk at portfolio level is MSCI Transition CVaR (policy risk and technology opportunities (1.5°C scenario). This choice is based on MSCI Transition CVaR providing satisfactory results when tested using past transition risk events and being reasonably aligned with our sector pathway approach.

Climate beta was developed as an additional proprietary metric to assess transition risk. The concept was first tested in an academic paper that explored alternative metrics to capture transition risk[12]. This metric uses market returns to understand the sensitivity of stock returns to climate risk events. In practice, we construct a portfolio of climate laggards minus leaders using the Robeco SDG and Climate Traffic Light frameworks. We then calculate the beta of a stock's return to the returns of the laggards, minus the leaders portfolio and then call this climate beta. A high climate beta indicates that a stock is likely to underperform in a climate risk event, whereas a negative climate beta indicates a stock is likely to outperform.

11. https://www.policyuncertainty.com/climate_uncertainty.html
12. Carbon Beta: A Market-Based Measure of Climate Transition Risk Exposure by Joop Huij, Dries Laurs, Philip A. Stork, Remco C. J. Zwinkels :: SSRN

We see complementary informational value in climate beta because it is not based on climate modelling, but on tracking market price volatility. It also provides a benchmark for evaluating MSCI CVaR and enables us to use proprietary information for commercial reasons when required.

4.2 Physical risk

To inform our investment decisions, we aim to factor in the expected financial costs that a company may incur from future weather related events. These range from damage to assets or disruption to supply chains by acute weather events such as a cyclone or a flood, to lower labour productivity from a chronic change such as an increase in extreme temperatures, to reduced demand for products as a result of a disruption to the end client.

Physical risk can be broken down into 3 components[13].

1. Hazard data (expected weather events) at specific locations. For example, at each location, for each year, a prediction of the number of days of heat or heavy precipitation days above a certain threshold, or the probability of extreme winds or flooding is made. This is obtained by using complex global climate models that are then downscaled to specific locations, with the support of catastrophe models and local topography maps.
2. Exposure data (location of assets) of a company. As companies do not typically disclose their assets publicly, this requires the building of an asset database which collects asset data from global and local databases and maps the ownership to a parent company. The number of assets can be extensive. According to Bloomberg data, Apple, for example, has more than 500 stores and another 50+ factories.
3. Vulnerability data (type of assets). For each asset, knowledge of the asset type (office, manufacturing plant), building type (materials – cement/glass), number of floors (e.g. ground floor more likely to be flooded) is needed in order to predict likely physical damage.

Calculating physical risk requires a vast amount of data collection, data cleaning and extensive modelling. We therefore decided to procure physical risk data externally. Our focus is to understand the different models available and their limitations so we can choose the best possible source in the market.

For this process, we evaluated 14 providers of physical risk. The key criteria used were:

1. Science-based: Is the provider's model using the latest available climate models? Do they have a reasonable way to scale down global climate models which are typically 100km x 100km resolution at a minimum, to the localised level needed to estimate physical risk at the asset level?
2. Asset database: How big is their asset database? Is it transparent? What types of assets are being picked up? Do they have a model to estimate the value of each of the assets? Do they use multiple sources to locate and attribute assets?
3. Cost model: Does the provider estimate costs on a bottom-up, asset level basis? Do they translate the cost to the company level? Do they split the cost between equity and debt?
4. Service level: Do they have physical climate change experts who can speak to us? Are they responsive to feedback on specific companies? Are they transparent with their methodology and databases? Are there significant resources dedicated to continuous improvement?
5. Coverage: What level of coverage do they have of corporate equity and fixed income universes?

Based on this assessment, we selected MSCI physical risk CVaR.

Even with the best model in the world, there is still a high level of uncertainty about the future potential costs a company could incur from physical risks. The estimation of physical risk costs is based on: knowing where the assets of a company are, knowing what weather related events that location will be exposed to and with what probability, estimating how vulnerable the asset is to that particular weather hazard and knowing how much value or revenue could be lost.

Each of these steps contains significant uncertainty. Companies do not often disclose the location of their assets, so providers need to derive the locations, type and value from multiple databases. For any given temperature scenario, there are multiple global climate models, each with different outcomes with various levels of granularity. There are various techniques used to downscale these outcomes to the asset location level, which also creates uncertainty.

13. ngfs_physical_climate_risk_assessment.pdf

The Climate Value at Risk figure can give a false sense of precision by being a single number per company, per temperature scenario. For this reason, we have translated the CVaR figures into physical risk categories to help guide investors to the relative importance of each CVaR value. This is based on the level of physical CVaR, the sector in which the company is active, as well as the contribution of extreme heat to the overall CVaR. We focus on extreme heat because we view the impact of this hazard as highly dependent on the sector in which a company operates. For example, if all operations are indoors & it is not a particularly water intensive sector, then we believe the impact of extreme heat should be limited. On the other hand, a company operating in the construction or agriculture sectors would likely be negatively impacted by extreme heat.

Figure 11 | Robeco physical risk categories

High	Medium	Low	Minimal
Company is likely to experience significant disruption due to future extreme weather events	Company is likely to experience some disruption due to future extreme weather events	Company is likely to experience small disruption due to future extreme weather events	Company has minimal exposure to future extreme weather events

We choose to use the NGFS REMIND NDC (average) scenario as our central scenario for quantifying physical risk for investment purposes. This scenario corresponds to a temperature rise of approximately 2.6°C by 2100 which is conservative, however, remains realistic in the unfortunate situation that no more action is taken.

5. Conclusion

We look at climate change through the lens of double materiality. As a result our approach to climate analytics reflects this.

We take different approaches depending on the metric and the question we are trying to answer.

Financial Impact

- Physical risk: Despite the estimation of physical risk being inherently uncertain, we found the most consistency in approaches across providers. The choice to be made was therefore to select a provider with output best suited to our use case and with the most up-to-date and comprehensive asset database and climate models. To ensure usability of this data by investors, we developed a simplified model to categorize physical risk. Investors can use this to adjust their valuation models to understand the additional risk faced by a company.

- Transition risk: We look at transition risk from both a bottom-up company level fundamental view and a top down portfolio level view. The bottom-up assessment relies on the sector pathway research and the sector knowledge of our SI Research analysts to calculate the financial impact due to additional capex and opex required, as well as potential policy costs. The top down view takes two different approaches, one which considers the sensitivity of companies to future carbon pricing based on their current carbon footprint (MSCI CVaR) and one which uses market return data to estimate the sensitivity of a portfolio to transition risk (climate beta).

Climate Impact

- Paris Alignment: We found that external data providers' approaches to alignment diverged and lacked transparency. For this reason, we created our own proprietary assessment of alignment, called the Robeco Climate Traffic Light. This gives us control over the assumptions made and visibility of the underlying data. It also allows us to enhance the assessment when underlying data is still relatively new (for example emission reduction target data). We use it to channel finance towards companies which are leading the transition as well as for voting and engagement purposes.

- Climate Impact: We developed our own measure of climate impact, the Robeco Climate Score. We use it to have a holistic view on a company's climate impact and construct portfolios to meet specific climate objectives.

As with all scores and assessments, their accuracy depends on the quality and availability of the input data. Currently, some of the key data points, such as target data are inconsistently reported by companies leading to different interpretations. Even emissions data, which is the most commonly cited climate data point, is still not reported consistently across companies[14]. There are also some critical data points that are largely absent from company disclosures, for example data about the use of offsets in transition plans, and capital allocation plans. We expect this to improve with upcoming disclosure standards and regulations (ISSB, SEC, EFRAG, UK TPT). Climate solutions and regional pathways are two areas where more data is needed and we aim to work innovatively on this. We expect our approach to evolve as new data sources and methodologies become available.

Even with perfect data, transition plans are complex, subject to change, and difficult to fully capture quantitatively. We view our analytics as a robust starting point and aim to enhance our assessments with detailed analysis. We acknowledge that our forward-looking approach is not a crystal ball yet, however, it is a powerful tool for building investment strategies in support of the climate transition.

14. Policies urgently needed to address emissions data gap, says central banking group (responsible-investor.com)

ROBECO
The Investment Engineers

Important information

Additional Information for US investors

Additional Information for investors with residence or seat in Canada

Please visit the Robeco website
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