Investing in the low-carbon transition

The roads to a low-carbon transition

What it means for investors

March 2020

HSBC
Global Asset Management

For professional investors only.
Not for further distribution.

This report was commissioned and produced by HSBC Global Asset Management. All modelling and calculations by Vivid Economics.

Contents

Executive summary

In its Special Report, Global Warming of 1.5°C, published in late-2018, the Intergovernmental Panel on Climate Change (IPCC) maps out the devastating impact 2°C above pre-industrial global temperatures could have on the environment and the economy. The report makes a clear case for limiting global warming to well below 2°C, which will require fast and significant structural changes in the global economy – and meaningful action from policymakers, financial institutions and corporations.

A key challenge for investors is understanding how the transition to a low-carbon world might impact asset valuations. The problem is, as noted by Mark Carney, the outgoing Governor of the Bank of England and UN special envoy for climate action and finance, the nature of climate risk – large, potentially non-linear and with uncertain time horizons – makes assessing a company's resilience for transitioning to a low-carbon world especially difficult.

Uncovering value along the low-carbon journey

The first step is improving transparency and information, which is what the Task Force on Climate-related Financial Disclosures (TCFD) has set out to do. Published in June 2017, the TCFD's recommendations are intended to establish a consistent, comprehensive disclosure framework to provide decision-useful information on the risks and opportunities of climate change. One of their recommendations is to use scenario-based analysis to estimate how various pathways might impact future value.

The role of scenario-based analysis

Scenario-based analysis uses various scenario and baseline factors as inputs along with integrated assessment models to consistently estimate key variables for diverse pathways. Outputs from scenario modelling can then be used to draw conclusions about the implications of a company's valuation. This approach can be a powerful tool for exploring policy and technology uncertainties in the low-carbon transition.

In December 2017, HSBC Global Asset Management began working on its climate scenario analysis with Vivid Economics to develop a construct for understanding company-level climate-related risks and opportunities to help investors make informed decisions. The first report, published in 2018, included six potential scenarios, three focused on policy timing and three on future technology costs. Following the IPCC 1.5°C special report, we expanded our initial work – increasing the number of scenarios to 10 to represent a broader range of low-carbon futures and taking into account the latest IPCC carbon budgets.

Ten climate-related scenarios

As with the original analysis, our updated scenarios are based on two main drivers of the low-carbon transition: climate policy and regulation; and, the cost and performance of technology designed to reduce emissions. We built on these by looking at increased policy stringency, varying policy timing and updated technology scenarios as well as implications for credit ratings.

	Scenario
Baseline	No New Action
	Paris NDCs
Climate policy	Below 2DS
	2DS Balanced Transformation
	Late Action
	Lack Of Coordination
Technology	Renewable Revolution
	Room for CCS
	Efficiency Boost
	EVs Unplugged

Baseline scenarios

- **No New Action:** Provides a baseline that reflects existing climate policies and estimated technology cost trends with no further policy changes
- **Paris NDCs:** Incorporates the potential effects of announced policies, including Nationally Determined Contributions (NDCs) made for the Paris Agreement in 2015

Policy timing and stringency scenarios

- **Below 2DS:** Explores implications of a climate target well below 2°C, using more stringent policy than the 2DS Balanced Transformation scenario
- **2DS Balanced Transformation:** Assumes globally coordinated action in 2020 to limit global warming to 2°C above pre-industrial levels by 2100
- **Late Action:** Rests on the same assumptions as the 2DS Balanced Transformation scenario but with globally coordinated action delayed until 2030
- **Lack of Coordination:** Based on the same assumptions as 2DS Balanced Transformation but instead of coordinated action it presupposes that carbon prices diverge between regions – converging to a single global carbon price by 2100

Technology cost scenarios

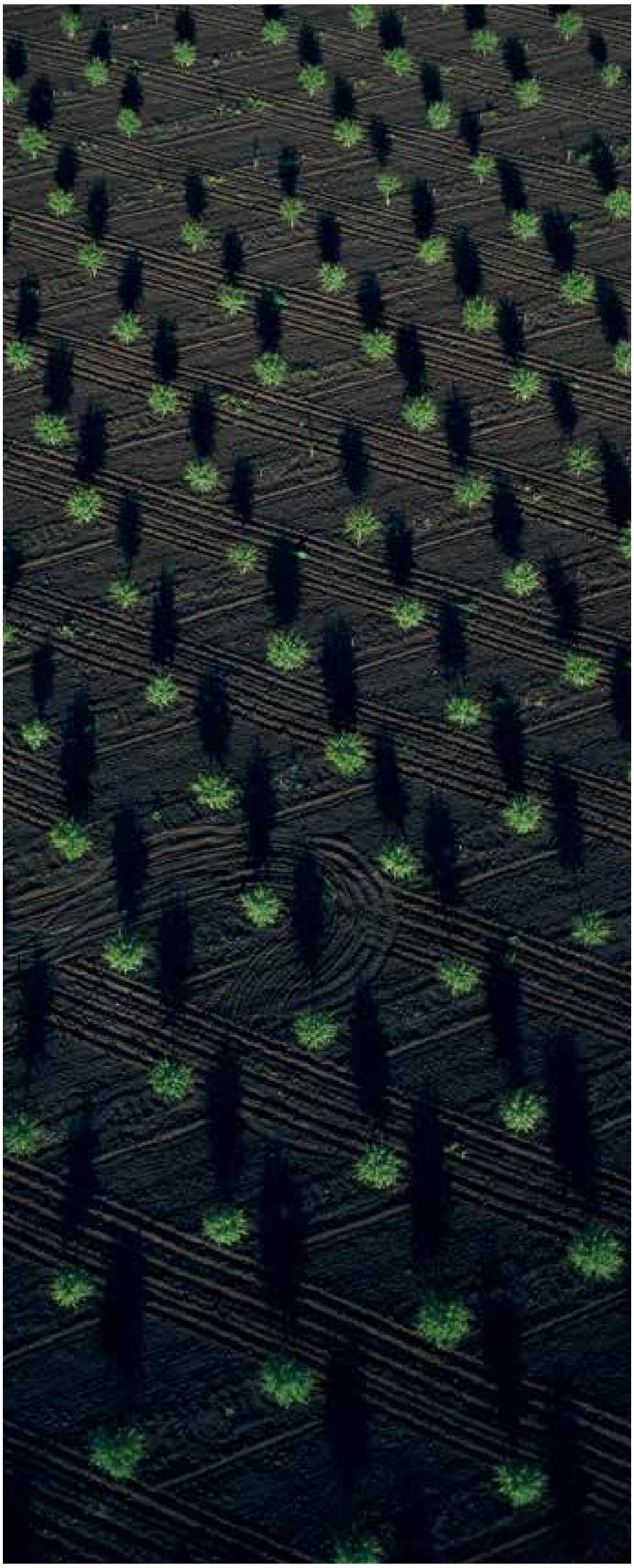
- **Renewable Revolution:** Assumes that the costs of both solar and wind equipment fall faster than expected
- **Room for CCS:** Explores a future where carbon capture and storage (CCS) becomes cost-competitive with renewables faster than expected
- **Efficiency Boost:** Assumes increased uptake of energy efficiency measures across all sectors of the economy, resulting in reduced energy use for a given level of GDP
- **EVs Unplugged:** Presupposes an aggressive reduction in the cost of electric vehicles (EVs)

Translating outputs into company valuation

We used three bottom-up value stream models to estimate company-level revenue and cost flows under each scenario.

- **Carbon costs and competition:** Considers how companies cut direct carbon costs, whether by abating emissions or passing through cost increases to customers
- **Fossil fuel demand destruction:** Estimates the effect of lower global output for fossil fuels for companies involved in extraction and production processes as well as coal producers and conventional automobile manufacturers
- **Green upside:** Looks at demand growth of clean technology companies due to the lower emissions associated with their products

This modelling approach includes a range of simplifying assumptions in order to produce consistent results across scenarios for a large number of companies. Breaking down the impacts along the three value streams in this way allows for greater transparency into how the various paths to a 2°C or below 2°C world might affect companies and what that means for shareholders and bondholders.



Key findings

We analysed a representative set of over 2700 global companies modelled on the MSCI All Country World Index (ACWI), using the Paris NDCs scenario as an illustrative baseline scenario against which to estimate impact – although other scenarios, such as No New Action, could also be used as a baseline depending on an investors' in-house views. We moved to this baseline as we now consider this a more appropriate baseline given the momentum of corporate action and increased scrutiny from civil society. Our analysis identified common characteristics of relative 'climate winners' and 'climate losers' across scenarios, even those in emissions-intensive sectors.

- The coal sector has the most significant negative mean impact (40%) under the 2DS Balanced Transformation scenario
- Concrete and cement companies have the largest range of positive and negative impacts across all scenarios
- Companies in the oil and gas sector vary significantly from the most and the least exposed
- A few companies in the oil and gas sector demonstrate some resilience under a range of scenarios
- Oil and gas, automobile manufacturers and renewable manufacturers are most sensitive across different technology scenarios
- Coal, concrete and cement, as well as iron and steel companies, are most sensitive across policy scenarios
- Clean tech companies stand to gain value in climate scenarios, but returns are sensitive to technology cost alternatives
- The worst hit sectors from a credit ratings perspective are oil and gas exploration and production, emissions-intensive industrials and power generators
- Automobiles and auto parts have a modest sector median downgrade in terms of credit ratings but a wide range between the best- and worst-performing companies
- Changes in credit ratings across emissions-intensive industrials are modest at first but the difference between the top and bottom performing 10% of issuers increases by 2050

How investors can put the results into action

Developing a modelling approach to explore the different low-carbon transition pathways at the company level helps investors better understand the risk exposure across asset classes as well as tailor specific engagement questions to get a sense of the resilience of a company's business and the robustness of their own scenario analysis.
These include:

- **Governance** – How has the Board considered the results of the scenario analysis? What implications has this had for investment decisions?
- **Strategy & scenarios** – How has the company approached scenario analysis?
- **Choice of scenario** – what rationale has the company used for the selection of the scenario or scenarios? Some scenarios have more favourable assumptions and therefore, outcomes
- **Key metrics and assumptions** – what are the inputs/ outputs for key variables, for example, the use of CCS, the role of gas, the implicit cost of carbon, renewable deployment or more sector-specific relevant assumptions such as EV updates and cost? Are there inherent biases or data limitations?
- **Scope of analysis** – has scenario analysis been applied to the company's full value chain or e.g. just costs associated with a carbon tax on operational emissions? In particular, have they reviewed the impact on their products/ suppliers?
- **Capability** – can the company run an analysis against another scenario or set of metrics? How frequently is the company planning to review these?
- **Risk management** – how is the company planning to respond? What are the company's abatement options and costs?
- **Metrics & targets** – What metrics is the company using to track company resilience to and opportunities from the transition? What targets – short, medium and long term – has the Board set in response?

While scenario analysis is a part of the TCFD's strategy recommendations, it is relevant to all disclosure areas, including governance and risk management as well as metrics and targets. Most of the companies that have taken steps to disclose against 2°C aligned scenarios have said there is either no downside or that it is negligible. Even though there are clear data limitations, undertaking a detailed scenario analysis can help demystify company disclosures and create constructive dialogue, ultimately leading to more robust and resilient portfolios. This type of scenario-based analysis will only become more important for investors as disclosure increases.

Introduction

Approaching five years on from the historic Paris Agreement and more than two years on from the Taskforce on Climate-related Financial Disclosures (TCFD) recommendations, companies and investors are still grappling with what transitioning to a below 2°C economy means for their businesses and portfolios. In this report, we outline the building blocks of scenario analysis, one approach to translating this analysis into impacts on company valuation and credit ratings, as well as highlight key questions for investors to ask when engaging with companies.

The scale and pace of change

The landmark Intergovernmental Panel on Climate Change (IPCC) report in October 2018 provided the clearest evidence to date that even 2°C of warming above pre-industrial temperatures may have significant environmental and economic costs. Limiting global warming to well below 2°C will require rapid and far-reaching structural changes to the global economy. Faced by this challenge, policymakers have set guidelines for implementing the 2015 Paris Agreement under which all countries will have to report and curb emissions in line with their Nationally Determined Contributions (NDCs). At this year's critical Conference of Parties (COP26), the Paris process requires countries to share their updates or second round of NDCs.

Climate change remained a central focus for the UN General Assembly in September 2019. Notable announcements included Russia's intention to formally sign on to the Paris Agreement and Germany's joining the Powering Past Coal Alliance. The UK, France, Norway, Finland and Chile as well as a host of other countries with smaller carbon footprints have committed to net zero carbon emissions. The UK target to be net zero by 2050 is legally binding through its Climate Change Act. However, not all net zero targets are supported by legislation or detailed sector policy pathways. Investors therefore face an uncertain transition[1].

The nature of climate risks

According to Mark Carney, the outgoing Governor of the Bank of England and UN special envoy for climate action and finance, the nature of climate risks – large, potentially non-linear and with uncertain time horizons – makes assessing the resilience of firms' strategies for low-carbon transition the biggest challenge in climate risk management. That's why the TCFD, as part of its financial disclosure recommendations, is advising companies to use scenario-based analysis to estimate climate-related risks and opportunities.

In its 2019 Status Report, however, the TCFD noted that companies are still early in the process of using climate-related scenarios internally. Nearly 50% of those surveyed said they were not using scenario-based analysis either because there were no standard scenarios or assumptions, or because the process was too complex or costly.

At the same time, we are now seeing a concerted move from voluntary to mandatory or quasi-mandatory reporting based on TCFD recommendations. Regulators and supervisors are increasing requirements on climate-related disclosure and investors are also more focussed on TCFD-aligned disclosure. The concept of stewardship is expanding as well and, in the case of the October 2019 update to the UK Stewardship Code, principles for asset owners and asset managers have been added to include systemic risk issues such as climate change.

While it is important to recognise the limitations of any scenario-based approach, we share the findings of this analysis and the implications for both integration and engagement for shareholders and bondholders.

1 CAT 2018 https://climateactiontracker.org/countries/ found that only 7 out of 31 assessed countries have Nationally Determined Contribution targets (NDCs) that are adequate to meet a 2°C target

Setting the scene

From voluntary to mandatory reporting on climate-related risks

Launched in June 2017, the TCFD final recommendations provide a framework for corporates and the financial community to develop more effective climate-related financial disclosures. A key recommendation is for companies to "describe the resilience of the organisation's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario."

While the TCFD recommendations are voluntary, we are seeing a move towards mandatory or quasi-mandatory reporting in addition to increased focus on disclosure from investors.

Widely adopted voluntary disclosure frameworks are aligning

- **Principles for Responsible Investment (PRI) –** By the end of 2020, over 2,000 global asset owners and asset managers participating in the PRI will be required to undertake TCFD-aligned disclosures
- **CDP –** This global disclosure initiative, supported by 540 investors and with over 7,000 companies, is now fully aligned with the TCFD recommendations

Regulators and supervisors are increasing requirements for climate-related disclosure and stress testing

- In France, climate-related reporting is already required, and they along with Belgium, Canada, Sweden and the UK have all formally announced their support for the TCFD recommendations
- In April 2019 the Bank of England Prudential Regulatory Authority (PRA) published their Supervisory Statement 'Enhancing banks' and insurers' approaches to managing the financial risks from climate change', which calls for boards of banks and insurers to incorporate climate change-related risks into existing risk management practice and disclosure. This includes identifying a senior executive to oversee climate change risk management and report to the board as well as using scenario analysis to test strategic resilience in December 2019, the Bank of England set out a proposed framework with multiple climate scenarios to test resilience against physical and transition risks as part of the 2021 Biennial Exploratory Scenario exercise
- In June 2019, the European Commission published new guidelines on reporting corporate climate-related information as part of its Sustainable Finance Action Plan, which integrate the recommendations of the TCFD
- The Network of Central Banks and Supervisors for Greening the Financial System (NGFS), a forum of 55 central banks and supervisors as well as 12 observers, has released a recommendation for internationally consistent climate-and environment-related disclosure. The NGFS also "encourages all companies issuing public debt or equity as well as financial sector institutions to disclose in line with the TCFD recommendations."
- The UK COP26 presidency has stated it would be working with authorities to commit to pathways to make climate reporting mandatory

Investors are increasing their focus on TCFD-aligned disclosure

- The ClimateAction100+ investor initiative, made up of over 450 investors with more than USD40 trillion in assets under management, is requesting that the largest global greenhouse gas emitters provide enhanced corporate disclosure in line with the final TCFD recommendations. While investors are looking for all companies to produce credible TCFD reporting that also includes climate scenario analysis to test the financial resilience of businesses, the first ClimateAction100+ progress report noted only 30% of focus companies have formally supported the TCFD recommendations
- High profile shareholder resolutions have been filed that align with the goals of the ClimateAction100+ initiative in Europe and North America, including at Ford, General Motors and British Petroleum
- The CDP's 2019 Non-Disclosure Campaign saw 88 investors with nearly USD10 trillion in assets writing to over 700 companies across 46 countries to encourage further disclosure, aligned with the TCFD recommendations, on climate change, water security and deforestation

Expanding stewardship to include the consideration of systemic risks

In October 2019, the UK Financial Reporting Council (FRC) published the UK Stewardship Code 2020 – an updated set of stewardship principles that, for the first time, explicitly recognise the role asset owners and asset managers play as guardians of market integrity and in working to minimise systemic risks such as climate change.

Getting started

Introduction to scenario analysis

The use of scenario-based analysis is well-established in certain policy fields and investors commonly stress test portfolios for resilience under previous adverse events, such as the global financial crisis. This type of analysis can also be a powerful tool for exploring policy and technology uncertainties within the low-carbon transition, mapping out how different scenarios affect risks and opportunities.

Using forward-looking scenarios specifically focussed on climate-related risks came to the forefront as a key TCFD recommendation and is now set out by the Bank of England as a supervisory expectation for financial institutions.

While there is value in both the process and the outputs, the results are not predictions, but rather credible, distinctive and relevant pathways.

Adding value through scenario analysis

Scenario analysis can provide valuable insights into:

- Identification and assessment of exposure to a range of risks and opportunities at the asset, entity, portfolio or economy levels
- Monitoring exposure to risks and opportunities at the portfolio or business levels
- Enhancing valuation processes through net present value (NPV) impact, positive or negative, and sensitivity metrics, for example
- Informing asset allocation decisions
- Better evaluation of company disclosure on the robustness of the scenario analysis and resilience of strategy
- Targeted engagement by identifying priority companies and questions
- Understanding the likely implications and impacts of future policy and technology developments

Why scenario assumptions matter

Scenarios are not intended to represent a full description of the future, but rather to highlight central characteristics to better understand key drivers and possible outcomes. The aim is to cover a variety of alternative, plausible future states under a given set of assumptions and constraints.

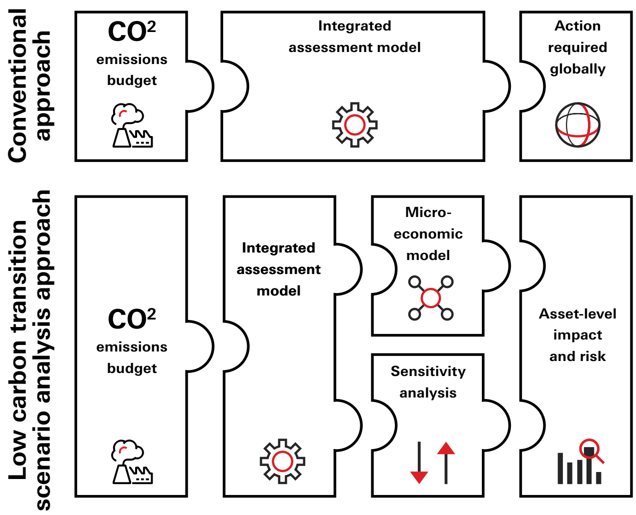
Fully understanding these assumptions and constraints, and the degree to which any key assumptions align with the house view is necessary to be able to interpret the scenario outputs. For example, an in-house analyst may have different assumptions for specific technology costs compared to those provided in standard scenarios. Changes to these inputs will lead to different valuations for specific companies.

Given that important input factors, such as carbon budgets and technology costs, are periodically updated – it makes sense to revisit scenario analysis at regular intervals rather than look at it as a one-off exercise.

How scenarios are modelled

Scenario modelling takes scenario and baseline factors as inputs and uses integrated assessment models to consistently estimate key economic and energy system variables, such as carbon prices or fossil fuel demand, across each scenario. Outputs from scenario modelling can then be used to determine company valuation implications.

Conventional scenario approach vs low-carbon transition scenario approach for investors



The dominant drivers of the low-carbon transition are climate policy and regulation and the cost and performance of technology designed to reduce emissions. Alongside these transition uncertainties, assumptions about GDP and population are also necessary. Varying these inputs and assumptions can significantly change the outputs as well as the results and conclusions that may be drawn from them.

Key scenario factors and assumptions

Factors and assumptions	Description
Carbon budgets	A carbon budget is the cumulative amount of carbon dioxide (CO2) emissions permitted over a period of time to keep within a certain temperature threshold. Different institutions – such as the International Energy Agency (IEA) or the IPCC - may use different budgets depending on:
Temperature limits	The Paris Agreement outlines the ambition to keep the rise in global temperatures to well below 2°C above pre-industrial levels and to pursue efforts to keep within 1.5°C of warming.
Probability of achieving these	Commonly used probabilities are 50% or 66%.
Timeframe	This varies, typically 2050 or 2100.
Scope and sector allocation of budget	IEA refers to carbon budgets for the energy sector only, which is the largest single source of anthropogenic CO2 emissions through the burning of coal, oil and gas. In contrast, the IPCC's budgets are for all anthropogenic sources of CO2. This means the IPCC includes carbon budgets for heavy industries and land use, land use change and forestry (LULUCF). This may also vary within the energy sector between coal, oil and gas.
Carbon capture and storage (CCS) and net-negative emissions technologies (NETs)	Technologies designed to remove CO2 from the atmosphere vary in their cost and scale of impact. For example, including high expectations for use of CCS are often challenged because the technology is yet to achieve commercial scale.
Policy	Type of policy or implicit carbon price, whether global or regional in breakdown and how it is implemented.
Technology	Uptake of different technology options dependent on price. For example, there are significant differences in renewable energy or electric vehicles (EVs), which can of course also be influenced by policy.
GDP	Current and projected, which vary by source.
Population	Current and projected, which vary by source.

Using off the shelf scenarios

There are a number of climate or energy scenarios available that are generally well-suited for estimating macro indicators such as energy productivity, carbon intensity and emissions[2]. However, these scenarios are designed for policymakers and often fail to consider variables and uncertainties relevant to asset managers and asset owners. For example, existing IEA scenarios have identified the differences in key variables under a 2°C scenario compared to a more stringent below 2°C scenario[3]. Still, they do not offer a systematic assessment of the impact of differences in policy timing, technology costs or the interaction of these factors. Qualitative or narrative scenarios can also be useful in exploring strategy and trends but are less useful for quantitative analysis.

Our scenario-based approach takes the analysis a step further to help investors understand the potential risks and opportunities and to make informed decisions at the aggregate asset level.

2 Appendix 1 provides examples of 'off the shelf' scenarios

3 The International Energy Agency's 2DS and B2DS (Beyond 2 degrees) scenarios are produced as part of its Energy Technology Perspectives (ETP) publication, with the current edition, ETP 2017https://www.iea.org/etp/etp2017/

Building a bespoke scenario framework

Our work on climate scenario analysis began in December 2017 with the objective of developing a framework for understanding company-level climate-related transition risks to help investors make better-informed decisions. We worked with Vivid Economics to design a suite of scenarios, together with a model to translate these scenarios into valuation impacts.

In 2019 we expanded on this initial effort – developing our own scenarios using a consistent design and modelling framework that allows for greater specification and ensures the results from each scenario are directly comparable. This is essential for assessing the impact of different assumptions on scenario outputs. We identified 10 scenarios that represent a broad range of low-carbon futures, influenced by two primary factors: climate policy and regulation; and, the cost and performance of technology options available to reduce emissions.

Developing divergent low-carbon transition scenarios

	Issue	Approach	Investment implication
Policy stringency (global and regional)	Uncertainty at the global-level around public and policymaker willingness to act on climate change Further uncertainty around how the burden of climate action will be divided across countries and regions	To capture the role of policy stringency at the global-level, emission budgets consistent with limiting global warming to 1.75°C (Below 2DS) and 2°C above pre-industrial levels by 2100 were considered To capture differences in the burden of climate action across regions, a Lack of Coordination scenario was estimated and compared against the 2DS Balanced Transformation in which all regions face the same burden of climate action	Most portfolio exposure tends to be weighted towards developed rather than emerging markets
Policy timing	No consensus on when coordinated action on climate change will achieve levels consistent with limiting warming to 2°C or below	Two timeframes for action were explored: Early action, where significant advances on current policy commitments begin in 2020 Delayed action, where significant advances on current policy commitments only begin in 2030	Equity valuations tend to be based on short-term profitability, and credit ratings tend to focus on under 10 years Due to discounting, a carbon price of USD80/ tonnes CO_2 in 2020 is much costlier than the same carbon price in 2030

	Issue	Approach	Investment implication
Technology	Uncertainty around the future cost of key emissions reduction technologies, which feeds through to uncertainty around the deployment of each technology and the overall cost of the transition	One central case and four extreme cases of technology cost were identified: Central technology cost assumptions are best estimates based on available data on technology costs today, and the academic literature and industry estimates on future costs for cheaper renewables, cheaper CCS, cheaper efficiency and cheaper EVs	Sector level impacts depend on the technology pathway

The 10 scenarios are designed to explore policy stringency, in terms of both global temperature increases and regional variance, policy timing and technology pathways, with one central and four more extreme cases of technology costs[3]:

Baseline scenarios

No New Action: This scenario provides a baseline reflecting existing climate policies and predicted technology cost trends with no further policy changes. This pathway would likely lead to global warming in excess of 3°C above pre-industrial levels by 2100.

Paris NDCs: This scenario incorporates the potential effects of announced policies, including the NDCs made for the Paris Agreement. This would likely lead to global warming of around 3°C above pre-industrial levels by 2100.

Policy timing and stringency

Below 2DS: This scenario explores the implications of a climate target well below 2°C. It rests on the same assumptions as the 2DS Balanced Transformation scenario but uses more stringent policy and satisfies an IPCC budget that limits global warming to roughly 1.75°C above pre-industrial levels by 2100.

2DS Balanced Transformation: This scenario assumes globally coordinated action starting in 2020 to limit global warming to 2°C above pre-industrial levels by 2100. Global coordination means all countries face the same carbon price to decarbonise. It is based on central estimates of future decarbonisation technology options costs provided by Imperial College London.

Technology costs

Renewable Revolution: This scenario assumes that costs of both solar and wind equipment fall quicker than under central technology cost assumptions.

Room for CCS: This scenario explores a future where CCS becomes cost-competitive with renewables faster than expected. The relative cost of natural gas and biomass energy carbon capture and storage (BECCS) is lower and the relative cost of renewables is higher.

3 To ensure the scenarios provide a broad range of low-carbon futures, each of the key design elements were varied systematically. A 2DS Balanced Transformation scenario was selected around which each design element is varied to produce seven divergent low-carbon transition scenarios. The eight low-carbon transition scenarios are then compared against two baseline scenarios: No New Action and Paris NDCs.
Source: HSBC Global Asset Management/Vivid Economics

Policy timing and stringency	Technology costs
Late Action: This scenario rests on the same assumptions as the 2DS Balanced Transformation but assumes that globally coordinated action is delayed and first deviates from Paris NDCs in 2030.	**Efficiency Boost:** This scenario assumes increased uptake of energy efficiency measures across all sectors of the economy, leading to a general fall in energy use for a given level of GDP. This reduces the need for more expensive sources of emissions reductions, such as fuel switching in industry or CCS in power and industry.
Lack of Coordination: This scenario rests on the same assumptions as 2DS Balanced Transformation scenario, but instead of coordinated action it assumes that carbon prices diverge between regions. The six regions used to define regional carbon prices are North America, Latin America, Europe, Africa and the Middle East, Asia and Australasia. Regions such as Europe with historically higher effective carbon prices due to energy use taxes and direct carbon pricing are assigned higher regional weights and therefore bear a higher proportion of the 2DS Balanced Transformation global carbon price. Regional carbon prices are assumed to converge to a single global carbon price by 2100, reflecting gradual catch up in climate policy stringency in regions with less rigorous action today.	**EVs Unplugged:** This scenario assumes very aggressive reduction in the cost of EVs, accelerating uptake beyond the IEA's Global EV Outlook 2015.

Scenario characteristics

The outputs resulting from our scenario analysis suggest that aggregate economic and energy system variables fluctuate depending on policy stringency and timing as well as the cost of abatement technologies. This is due to the divergence in key factors:

- **Average carbon price –** The average carbon price (2020 – 50) ranges from USD52/tonnes CO2 in the Efficiency Boost scenario, where energy efficiency improvements reduce overall energy demand, to USD114/tonnes CO2 in the Below 2DS scenario, where policy action is more stringent
- **Global fossil fuel production –** Global gas output is 13% higher in the Room for CCS than in the 2DS Balanced Transformation scenario in 2050
- **Total renewable capacity –** Total renewable capacity is 14% higher in the Renewable Revolution scenario than in 2DS Balanced Transformation by 2030

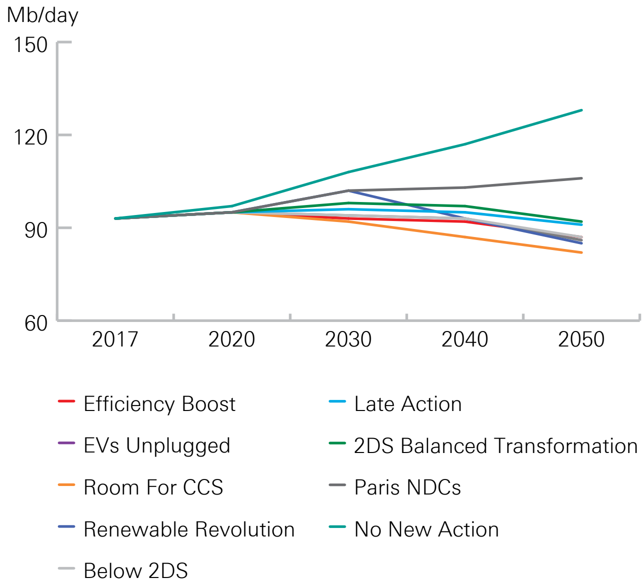
Carbon prices for different low-carbon transition pathways 2DS vary significantly relative to No New Action

Carbon price (USD/tCO2)

	Scenario	2020	2030	2040	2050
Baseline	No New Action	0	0	0	0
	Paris NDCs	15	40	21	15
Climate policy	Below 2DS	15	115	140	164
	2DS Balanced Transformation	15	73	69	74
	Late Action	15	40	77	103
	Lack of Coordination	variable			
Technology	Renewable Revolution	15	67	61	74
	Room Far CCS	15	79	90	91
	Efficiency Boost	15	64	56	57
	Evs Unplugged	15	64	58	71

Carbon prices are the primary comparable metric for gauging the stringency of a transition scenario. The above table shows the differences in carbon prices across all model scenarios, relative to No New Action. In the Paris NDCs scenario, prices are consistent with USD15/tonnes CO2 in 2020 and USD40/tonnes CO2 in 2030. There is still a carbon price associated with Paris NDCs after 2030. However, since NDCs commit the global economy to lower CO2 emissions in the future than in the No New Action scenario – this effect diminishes by 2050.

Oil output across different low-carbon transition scenarios



The No New Action scenario leads to the highest oil output at 108Mb/day in 2030, rising to 128Mb/day in 2050. The Late Action scenario results in much higher output in 2030, at 101Mb/day, reflecting no policy action beyond the Paris NDCs scenario until this year; after this output decreases sharply to 85Mb/day in 2050. Differences across the technology scenarios, Renewable Revolution and Room for CCS, are modest due to negligible use of oil in the power sector.

Shifts in power generation capacity

Coal, gas and hydro dominate the power sector today, representing over 70% of installed capacity. Solar and wind constitute around 13% and have smaller shares in generation. By 2050, the share of solar and wind in the No New Action scenario is over 30% and total capacity is double today's levels at around 14 Terawatts (TW). Under the Paris NDCs scenario, the 2050 power sector is even further decarbonised, with solar and wind making up around 40% of capacity and the share of coal and gas capacity down to 38%.

The 2DS Balanced Transformation scenario leads to very high solar and wind capacity distribution, with these technologies representing over 70% of installed capacity by 2050. There is no coal capacity in 2050 under this scenario, reflecting coal's position as the most emissions-intensive power source (in terms of grammes carbon dioxide per kilowatt hour – or gCO2/kWh). Small amounts of gas and nuclear capacity remain, illustrating the need for firm and dispatchable sources of power in future low-carbon electricity networks.

Note: Carbon prices are prices relative to the No New Action scenario; all values shown are from scenario modelling conducted by Vivid Economics in conjunction with Imperial College London. Source: HSBC Global Asset Management/ Vivid Economics

Across technology cost scenarios, the Renewable Revolution leads to the highest level of total capacity at 15.4TW in 2050. Solar and wind make up 72% of installed capacity in 2050 under this scenario. By contrast, the Room for CCS scenario results in much lower solar and wind penetration (45% of capacity in 2050) and higher gas generation capacity (10% of capacity in 2050). Total capacity in this scenario is lower at 8.8TW, reflecting the higher capacity factor (power output per unit of installed capacity) of fossil-fired generation plants compared to renewables. The Efficiency Boost scenario leads to slightly lower capacity build out than the 2DS Balanced Transformation scenario owing to lower power demand. The Below 2DS scenario is similar to 2DS Balanced Transformation, though with slightly more capacity overall.

Translating outputs into equity valuations and corporate credit ratings

We use three bottom-up value stream models to estimate company-level revenue and cost flows under each scenario. Although not necessarily comprehensive, and subject to the limitations of existing data, these value stream models are designed to capture the major channels through which the low-carbon transition may impact investor outcomes. We see that in many cases, this stage is oversimplified, losing much of the detailed insights as illustrated in the flow chart below.

Carbon costs and competition: In each scenario, all companies face direct carbon costs due to global carbon pricing. Companies can cut costs by abating emissions or by passing through cost increases to consumers. This is modelled using a microeconomic model of sectorial competition, financial (Thomson Reuters Datastream) and emissions data (Trucost). This model is applied on a sector basis, covering over 130 individual markets.

Fossil fuel demand destruction: Demand destruction estimates the effect of lower global output for fossil fuels on corporates involved in the associated extraction and production processes. This is modelled through economic analysis of each market as well as oil and gas industry data (Rystad Energy). Demand destruction also affects coal producers and conventional automobile manufacturers.

Green upside: Clean technology companies experience demand growth due to the lower emissions associated with their products. This is modelled using existing market share (FTSE Russell Green Revenue) and green patent data (Orbis Intellectual Property). Potential new entrants into these markets are not included in the analysis.

These three value stream models produce business segment level cash flow estimates under each climate scenario. These are then aggregated to the company-level and discounted back to NPV terms using a standard equity discount rate. Value impairment for an equity under each low-carbon transition scenario is defined as the percent change in NPV scenario profits compared to a baseline scenario. Corporate debt impacts are estimated using changes in fixed income instrument credit ratings based on the Altman Z-score[4].

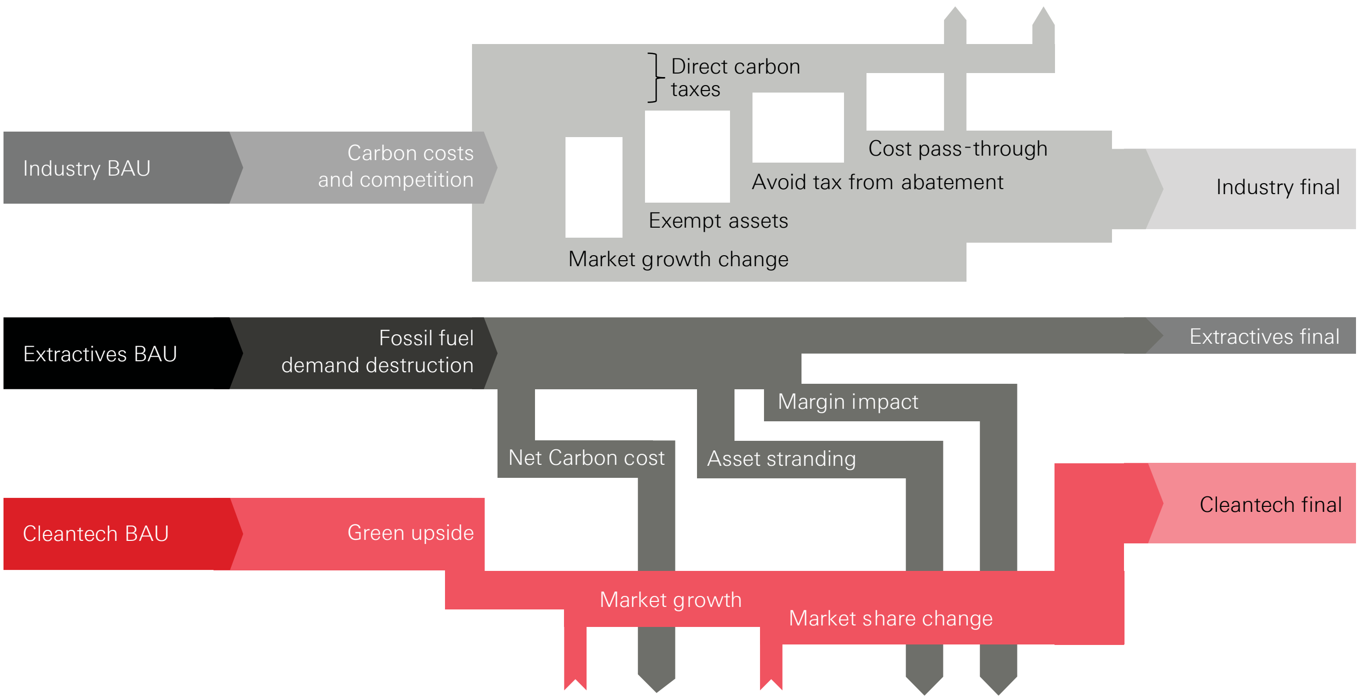
Measuring the impacts on equity valuations and corporate credit ratings is complex. That's why our modelling approach also considers several simplifying assumptions in order to produce consistent results for a very large number of companies across the various scenarios. While recognising the inherent limitations of such an approach, the benefit lies in helping investors understand how securities may perform in each scenario, all other factors remaining equal.

Our fundamental research for both equity and corporate credit each combine multiple qualitative and quantitative metrics and ratios to determine valuations and model ratings. These scenario impacts represent consistent quantitative inputs to inform and complement our systematic and fundamental analysis. For example, for corporate credit, given that certain sectors have tolerance for higher leverage, using credit metrics from each scenario to determine whether an upgrade or downgrade from the current rating level of the issuer is warranted, and estimating the change in credit spread impact by industry would provide more accurate insights. At this stage, we have also not factored in the impact of the maturity profile of individual bonds.

4 This analysis estimates credit ratings impacts using the discounted cash flow analysis from the equity analysis to determine the impact of each climate scenario on the Altman Z-score. Here we are using the score to determine relative changes in credit ratings within sectors rather than absolute default risk.

Illustrative flow chart demonstrating value creation and destruction across the three value stream models

Ex-ante value	Value stream models	Mechanism of value change	Ex-post value
Consider the following portfolio	The value of this portfolio is impacted by:		The estimated new value would be:



From analysis to action – investment implications

What did we do?

The approach we have chosen – breaking down the impacts along the three value stream models – provides greater transparency on the means by which the multiple paths to a 2°C or below 2°C world impact companies and, in turn, the implications for shareholders and bondholders.

We analysed a representative set of over 2700 global companies modelled on the MSCI All Country World Index (ACWI) to provide a view of challenges and opportunities across sectors and regions as well as the magnitude and variance in entity-level impacts, both positive and negative. We released our first report in October 2018, providing an overview of our approach and insights into the impact on equity valuations. Following the publication of the IPCC special report[5] on the effect of global warming of 1.5°C, and the associated updates on carbon budgets, we re-ran the analysis.

Our updated analysis included an expanded set of 10 scenarios – looking at increased policy stringency and varying policy timing, updated carbon budgets and technology costs – and explored the implications for credit ratings. The scenarios cover a range of different policy, carbon pricing and technology scenarios, including those in the ranges outlined within the Forecast Policy Scenario[6].

This section provides an overview of results and insights in the following areas:

- Sector level impacts across a range of scenarios for both equity valuations and credit ratings
- Implications for company engagement on scenario analysis

Selecting a baseline

In this analysis, we use the Paris NDCs scenario, under which countries implement Paris Agreement NDCs but no further policies, as an illustrative baseline scenario against which to estimate impact. We moved to this baseline as we now consider this a more appropriate baseline given the momentum of corporate action and increased scrutiny from civil society.

We have not attempted to estimate what level of future climate policy action is currently priced in to equity valuations or credit ratings by financial markets. Investors could opt to use other scenarios as a baseline, such as No New Action where only climate policies in existence are implemented, if there is an in-house view that this is what is priced in to markets.

It would be important to note, however, the potential for investors to have priced in different levels of climate policy action and technology changes for individual securities.

For example, Tesla may be valued based on high expected future demand for EVs, consistent with EV deployment levels under the Paris NDCs scenario. Still, Toyota Motors may be valued based on increasing future demand for internal combustion engine vehicles as in No New Action.

Sector level insights

1. Variation in outcomes across scenarios illustrates the potential risk associated with policy and technology uncertainty around the climate transition and emphasises the importance of both scenario and asset-level analysis when making investment decisions.
2. The analysis allows for the identification of common characteristics of relative 'climate winners' and 'climate losers' across illustrative scenarios, even in emissions-intensive sectors.
3. The coal sector has the largest negative mean impact under the 2DS Balanced Transformation scenario.
4. Concrete and cement companies have the largest range of positive and negative impacts across all scenarios.
5. Companies in the oil and gas sector vary significantly between the most and least exposed. However, a few companies demonstrate some resilience under a range of scenarios, including Below 2DS. Results indicate that two-thirds of profit losses are due to lower profit margins across continued operations rather than 'stranded assets'.
6. Oil and gas, automobile manufacturers and renewable manufacturers are most sensitive across different technology scenarios.
7. Coal, concrete and cement and iron and steel are most sensitive across policy scenarios.
8. Clean tech companies stand to gain considerable value in climate scenarios; however, returns are highly sensitive to technology cost alternatives.
9. The worst-hit sectors from a credit ratings perspective are oil and gas exploration and production, emissions-intensive industrials and power generators.
10. Automobiles and auto parts have a modest sector median downgrade, but a wide range between the best- and worst-performing companies.
11. Changes in credit ratings across emissions-intensive industrials are modest at first, but the difference between the top and bottom performing 10% of issuers increases to over three notches by 2050[7].

5. Intergovernmental Panel on Climate Change (IPCC) special report on global warming of 1.50 C above pre-industrial levels https://www.ipcc.ch/sr15/
6. See Appendix 1 for details
7. One notch is a credit rating change of 1 band, e.g., from Aaa to Aa1

Sector sensitivity

Certain companies are more sensitive across the range of scenarios, but drivers vary by sector for both equity valuations and credit rating impacts.

Climate policy scenarios vary by timing, stringency and regional coordination of policy action:

- **Below 2DS**, the most stringent policy scenario, leads to the largest impacts across exposed sectors compared to Paris NDCs, reflecting high carbon prices and a rapid transition away from coal
- **Late Action** is the most beneficial scenario for fossil fuel and emissions-intensive sectors, reflecting the high proportion of future profits investors expect companies in these sectors to make before 2030
- **Lack of Coordination** leads to high carbon prices in Europe and low prices in other regions, which has a proportionate impact for regionally exposed securities

Across the technology scenarios, the costs of key emissions abatement technologies vary:

- **Renewable Revolution** leads to a positive impact for renewable equipment manufacturers relative to Paris NDCs; for other sectors, impacts are similar to the 2DS Balanced Transformation
- **Room for CCS** leaves oil and gas exploration and production companies better off and renewable energy companies worse off, reflecting gas squeezing out renewables in the power generation mix – which is why the level of CCS built into scenarios is important to consider
- **Efficiency Boost** makes oil and gas companies and automotive manufacturers worse off with lower demand for fossil fuels and vehicles due to energy efficiency improvements – renewable generation equipment makers are similarly affected by lower power demand with a more modest uplift compared to 2DS Balanced Transformation
- **EVs Unplugged** is damaging to oil and gas companies, reflecting lower demand for oil in the road transport sector; automobiles are similarly hit with negative impacts due to the current low share of EVs manufactured as a proportion of all autos currently manufactured by carmakers listed on the MSCI ACWI

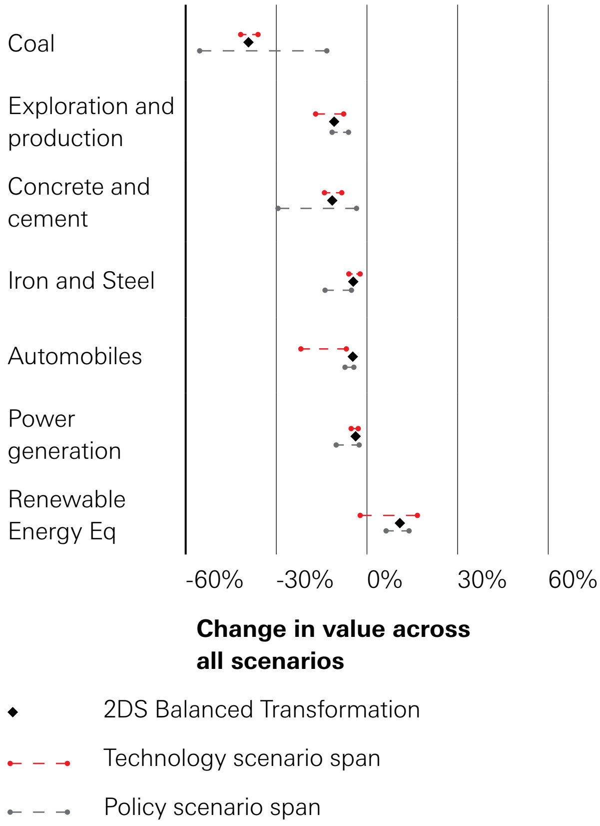
Equity valuations

Oil and gas, automobile manufacturers and renewable manufacturers are most sensitive across technology scenarios as these markets are more exposed to the level of adoption and use of key low-carbon transition technologies.

Coal, concrete and cement and iron and steel are most sensitive across policy scenarios as these markets are more exposed to carbon price levels.

While results suggest clean tech companies stand to gain considerable value in climate scenarios, returns are highly sensitive to technology cost alternatives. There is greater uncertainty around this green upside given that the future market structure and degree of competitiveness is yet to be determined.

Significant divergence across scenarios



Notes:

Impacts shown are changes in discounted profits relative to the Paris NDCs scenario
Bars show the range across technology and policy scenarios - Technology scenarios are Renewable Revolution, Room for CCS, Efficiency Boost and EVs Unplugged; Policy scenarios are Late Action, Lack of Coordination and Below 2DS
Source: Vivid Economics/HSBC Global Asset Management

Selected sector impacts across policy and technology scenarios—equity valuation

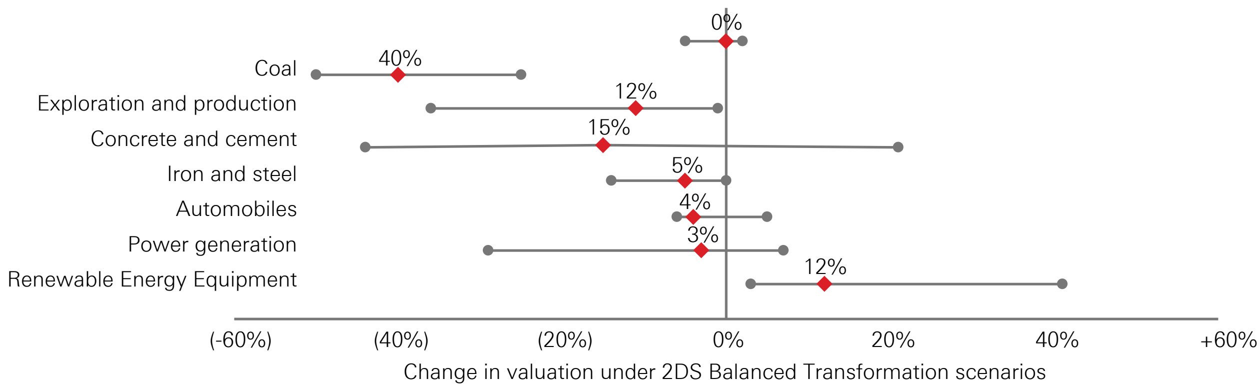
NPV relative to the Paris NDCs scenario as an illustrative baseline scenario against which to estimate impact.

Category	Scenario	Power generation	Exploration and production	Coal	Concrete and cement	Iron and Steel	Cars	Renewable Energy Eq.
Baseline	No New Action	5%	21%	191%	21%	6%	4%	-6%
	Paris NDCs	0%	0%	0%	0%	0%	0%	0%
Climate policy	Below 2DS	-5%	-12%	-53%	-29%	-12%	-5%	13%
	2DS Balanced Transformation	-3%	-12%	-40%	-15%	-5%	-4%	12%
	Late Action	-1%	-7%	-12%	-6%	-5%	-3%	8%
	Lack Of Coordination	-3%	-12%	-39%	-13%	-5%	-4%	12%
Technology	Renewable Revolution	-3%	-13%	-39%	-13%	-5%	-5%	17%
	Room for CCS	-4%	-8%	-42%	-17%	-7%	-5%	-1%
	Efficiency Boost	-2%	-18%	-36%	-11%	-4%	-14%	9%
	EVs Unplugged	-2%	-17%	-37%	-12%	-5%	-19%	12%
-	Policy variation	4%	6%	41%	22%	8%	2%	6%
	Technology variation	1%	10%	6%	6%	3%	14%	18%

Change in equity valuation

-30% 0% +30%

Differences in sector median and within sector impacts are large in the 2DS Balanced Transformation scenario

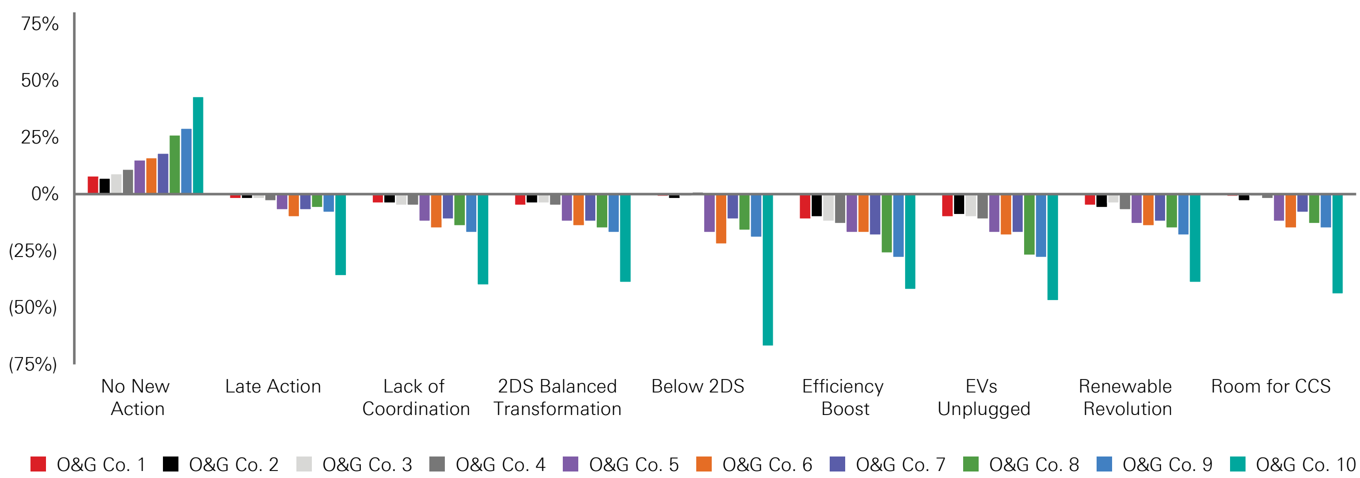


Percentage change in NPV relative to the Paris NDC baseline scenario

Companies in the oil and gas sector have significant variation

Recognising that the valuation impacts derived from the scenario analysis are based on the assumption that all else is equal, we can see the companies in the oil and gas sector range significantly between the most and least exposed.

Looking at the impact of the 10 largest oil and gas companies, collectively totalling approximately one-third of the integrated oil and gas exploration and production market cap of companies modelled on the MSCI ACWI, we see varying degrees of resilience under the different scenarios.

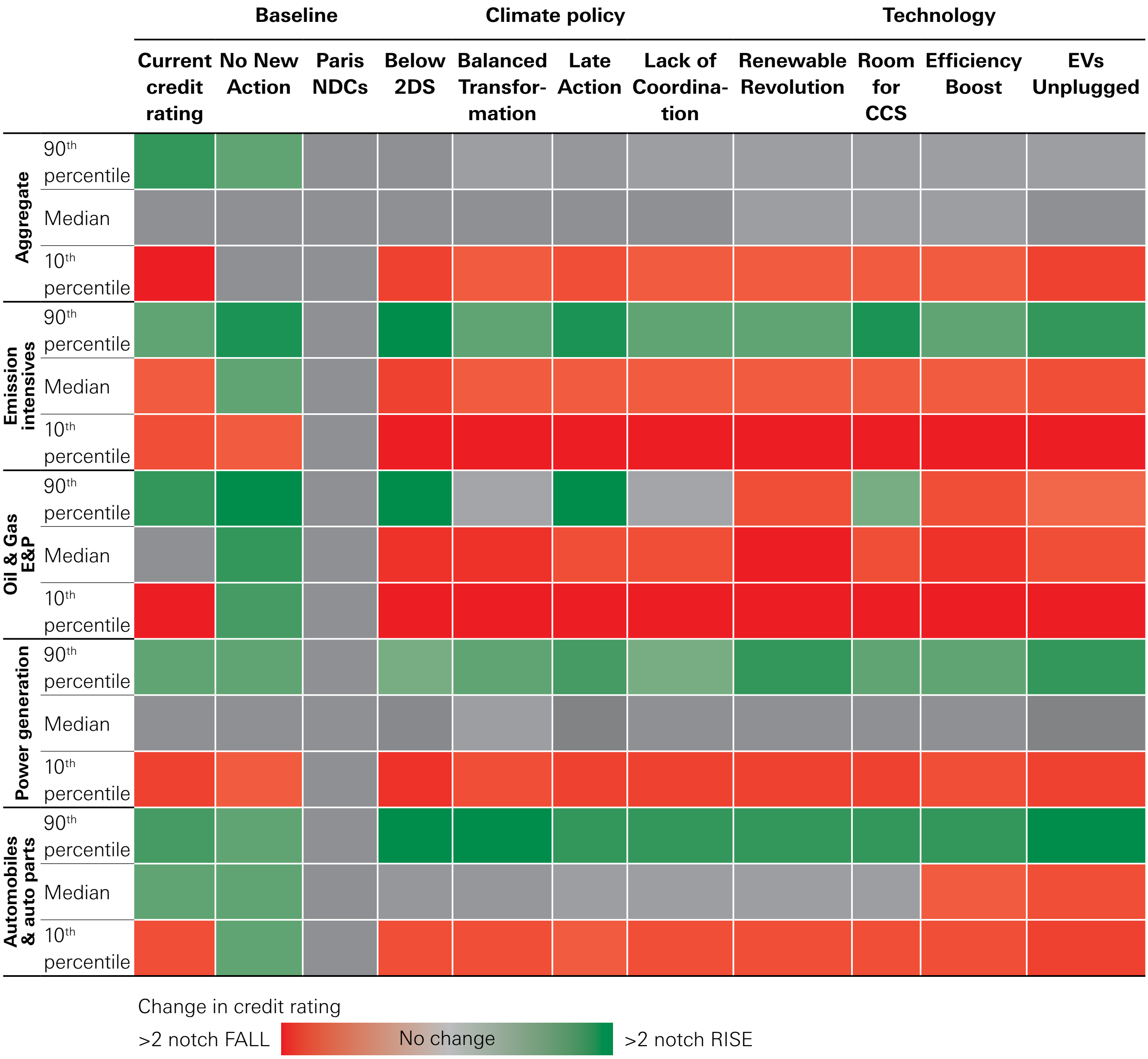


Notes:

Impacts shown are changes in discounted profits relative to the Paris NDCs scenario.
Bars show the range between the 10th and 90th percentiles of company performance within each sector, and for the MSCI ACWI as a whole; percentage labels refer to sector median values.
Model results are dependent on the number of listed equities in each sector – markets containing fewer listed equities may have less stable results.
Data from Thomson Reuters, Trucost, Rystad Energy, Orbis Intellectual Property, and FTSE Russell Green Revenue
Source: Vivid Economics/HSBC Global Asset Management

Selected sector level impacts and sensitivities – credit ratings

Fixed income issuers in the oil and gas sector are best off in the Late Action and Room for CCS scenarios where median downgrades are 0.5 to 1 notch. Emissions-intensive industrials are worst off in the Below 2DS scenario, also with an average credit rating downgrade of 0.5 to 1 notch, reflecting greater policy stringency and higher carbon prices. Across scenarios, exploration and production issuers are worst off in the Efficiency Boost and EVs Unplugged scenarios with average credit ratings downgrades of 1 to 1.5 notches. Power generators that are well-positioned in terms of their energy mix are likely to see a positive impact on their credit rating as they benefit from an increase in demand of low-carbon energy. EVs Unplugged and Efficiency Boost lead to the largest median downgrades for the automobiles and auto parts sector at up to 0.5 notches – the latter result reflects low light-duty vehicle deployment rates when energy efficiency improvement rates are high.



Notes:

One notch is a credit rating change of 1 band, e.g., from Aaa to Aa1.
Impact relative to Paris NDCs scenario as an illustrative baseline scenario against which to estimate impact.
Data from Thomson Reuters, Trucost, Rystad Energy, Orbis Intellectual Property, and FTSE Russell Green Revenue
Source: Vivid Economics/HSBC Global Asset Management

The worst performing 10% of issuers experience a credit rating downgrade of at least half a notch, while the best performing 10% experience an improvement of around one-tenth of a notch. The worst hit sectors, which are also large issuers of corporate debt, are oil and gas exploration and production, emissions-intensive industrials and power generators. Automobiles and auto parts have a modest sector median downgrade, but a wide range between the best- and worst-performing companies.

Credit ratings fall the most in oil and gas and emissions-intensive sectors, but company variation is large

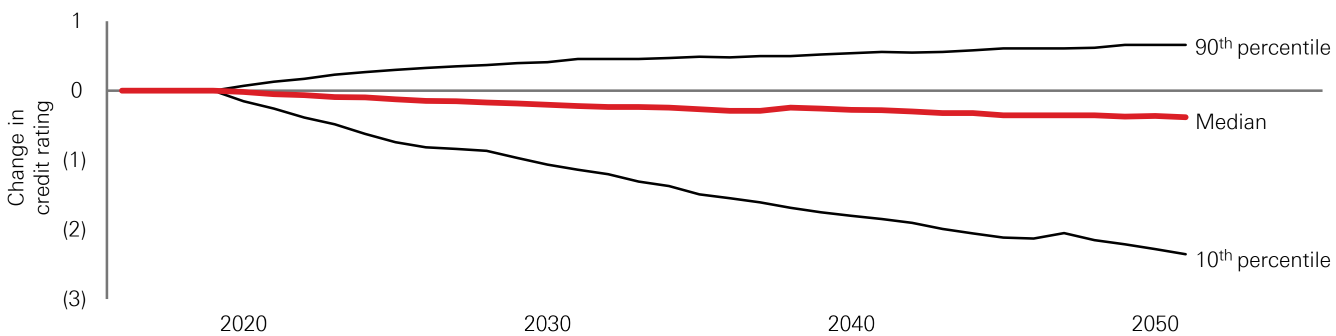
Corporate debt	**Credit rating**	**2DS Balanced Transformation**			**Median impact across scenarios**		
Parent sector	Median	10th percentile of companies	Median	90th percentile of companies	Lowest impact scenario	2DS Balanced Transformation	Highest impact scenario
Oil and gas E&P	Baa1						
Emission-intensives	Baa2						
Automobiles and auto-parts	A2						
Power generation	Baa1						

Change in credit rating

>1 notch FALL — No change — >1 notch RISE

Changes in credit ratings across emissions-intensive industrials are modest at first, but the difference between the top and bottom performing 10% of issuers increases to over 3 notches by 2050. The worst performing 10% of emissions-intensive industrial issuers have an impact of approximately 1 notch by 2030, rising to between 2 and 2.5 notches in 2050. The best performing 10% of issuers' credit ratings improve by up to 0.5 notches in 2030 and by 0.5 to 1 notch by 2050. Overall median credit ratings are on a downward trajectory incrementally over the decades between 0 and 0.5 notches.

Emissions-intensive industrial credit rating changes are modest at first, but the difference between the best and worst issuers is over 3 notches by 2050



Notes:

Change of -1 notch is equal to a credit rating fall of one band. Percentiles reflect the performance of different companies within each sector; Change in credit rating shown relative to Paris NDCs scenarioPercentiles refer to range of company performance around the sector median
Data from Thomson Reuters, Trucost, Rystad Energy, Orbis Intellectual Property, and FTSE Russell Green Revenue
Source: Vivid Economics/HSBC Global Asset Management

Scenario analysis is relevant across all TCFD disclosure areas

In the latest status report, the TCFD reported nearly 800 public and private sector organisations support their recommendations to use scenario-based analysis for disclosures. This includes global financial firms responsible for assets in excess of USD118 trillion.

As previously discussed, scenario analysis, by design, generally derives valuation impacts based on the assumption that all else is equal. This will clearly not be the case looking forward as we see companies take different approaches to making their businesses more resilient. This is why good climate-related disclosure is so critical to investors, not just for strategy but governance and risk management as well as metrics and targets.

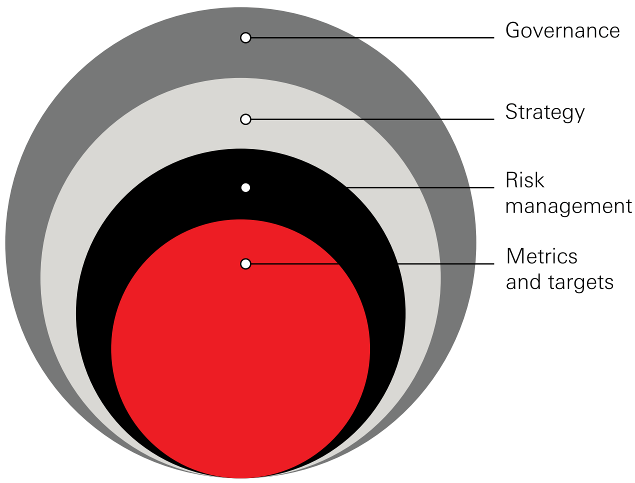
Governance. The results of scenario-based analysis are a critical component of climate-related considerations in board and management decisions. Although the outputs of scenario analysis are subject to some uncertainty, board-level review and discussion of this assessment with appropriate sensitivity analysis is an important element of governance and oversight. Meaningful evidence that the board have considered the outputs of the scenario analysis is a good indication that governance processes are linked directly into substantive strategy decisions, and credible metrics and targets across the organisation.

Strategy. The TCFD asks companies to assess the materiality of climate change to their businesses and disclose relevant exposure to climate-related risks and opportunities. This analysis suggests that examining a range of climate scenarios can provide valuable insight, as impacts vary considerably across the 10 scenarios. The range of scenarios should explore uncertainties around both policy and technology change, as well as how they impact one another, where possible. It further illustrates the value of having bespoke scenarios as different assumptions are more important to different sectors and investors. The implications of the scenario analysis should also be outlined, providing insights into the resilience of the company.

Risk management. Given the significant amount of within-sector variation across all scenarios in this analysis, there is room for worst-in-class companies to improve climate-related risk management. Investors could use results to encourage these companies to address areas of weak performance compared to competitors – for example, investments in energy efficiency measures and initiatives to reduce process emissions.

Metrics and targets. Currently investors must rely on companies to analyse exposure, not just through companies' own scenario analysis but from the metrics of asset location, product mix, cost of production and abatement potential, for example. Future improvements of scenario-based analysis are dependent on enhanced company disclosure of metrics and targets beyond the carbon footprint. The more granular the data disclosed by companies, the more informative the scenario-based analysis for investors can be. For example, analysis to date relies on abatement cost curves within sectors, which do not capture the options available to an individual company. It would be helpful to expand the information disclosed on carbon footprints, as well as list planned abatement investments and their costs. Forward looking capex and opex in relevant areas will also be critical to evaluate future exposure or resilience. For the demand destruction analysis presented in this report, it would be useful if fossil fuel extractors provided better public data on timing and production volume, including how these may change under different scenarios. Finally, to more accurately assess the green opportunities available to companies, greater detail on regional segmentation of green revenues and future plans to increase green revenues is needed.

Core elements of recommended climate-related financial disclosures



What should investors be looking out for?

The current backdrop is one where most of the companies that have taken steps to disclose against 2°C aligned scenarios disclose there is no downside or that it is limited. While some do refer to costs, there is little discussion of the need to change business models – however, this will not be the case for all companies. It is therefore important for investors to be able to scrutinize the scenario-related disclosures of companies in order to have meaningful conversations with them. Key questions and considerations for investors to ask are:

Engagement framework on climate-related scenario disclosure

1. **Governance** – How has the Board considered the results of the scenario analysis? What implications has this had for investment decisions?
2. **Strategy & scenarios** – How has the company approached scenario analysis?
   - 2.1. **Choice of scenario** – what rationale has the company used for the selection of the scenario or scenarios? Some scenarios have more favourable assumptions and therefore, outcomes.
   - 2.2. **Key metrics and assumptions** – what are the inputs/ outputs for key variables, for example, the use of CCS, the role of gas, the implicit cost of carbon, renewable deployment or more sector-specific relevant assumptions such as EV updates and cost? Are there inherent biases or data limitations?
   - 2.3. **Scope of analysis** – has scenario analysis been applied to the company's full value chain or e.g. just costs associated with a carbon tax on operational emissions? In particular, have they reviewed the impact on their products/ suppliers?
   - 2.4. **Capability** – can the company run an analysis against another scenario or set of metrics? How frequently is the company planning to review these?
3. **Risk management** – how is the company planning to respond? What are the company's abatement options and costs?
4. **Metrics & targets** – What metrics is the company using to track company resilience to and opportunities from the transition? What targets – short, medium and long term – has the Board set in response?

Conclusion

Climate-risks are very different from other investment risks. As noted earlier – the scale, non-linear nature and uncertain time horizons make these risks particularly challenging to assess in the short term. Scenario analysis provides a tool for both investors and companies to assess climate-related risks and opportunities from a top-down and bottom-up perspective.

Developing a modelling approach to explore the different low-carbon transition pathways at the company level allows investors to better understand the risk exposure across asset classes as well as tailor specific engagement questions to understand the resilience of a company's business. Individual security impacts can be aggregated in order to analyse the impact of scenarios across a portfolio and used to inform both systematic and active strategies. Exposure to both the downside and upside differs depending on whether you are a bondholder or shareholder. For companies that stand to gain from the low-carbon transition, bondholders may see greater resilience, whereas shareholders benefit from increased profits through higher dividends. For a company with moderate downside risk exposure in the low-carbon transition, shareholders are expected to suffer first, while bondholders are initially insulated.

The challenge for investors is that their exposure to climate risk is wide-ranging and varies according to asset class. While identifying and evaluating climate-related risks and opportunities for a single company and its value chain may be challenging, understanding climate-related impacts on the economy across sectors, regions and asset classes makes it even more complex. The potential for systemic changes in credit or equity risk brought about by the low-carbon transition must also be considered. The failure of a small group of firms could lead to a re-evaluation of all financial assets issued by a larger group of companies. For instance, the default of a few oil and gas companies could have a ripple effect across the sector.

Next steps

While there are clear data limitations, undertaking detailed scenario analysis can help demystify company disclosures and create a more constructive dialogue, leading to more robust and resilient portfolios. We continue to build on our low-carbon transition scenario analysis with:

- Systematic integration of transition risks into quantitative analytical frameworks and tools
- Improved accuracy of data inputs
- Identifying signals and likelihood of different policy and technology trajectories
- Determining appropriate baselines for what is already 'priced in' to the market
- Capturing qualitative considerations more systematically as part of the forward-looking assessment of a company's response to climate risk exposure

Appendix

Appendix 1: Off-the-shelf scenario examples

- The IEA publishes multiple scenarios with a range of associated temperature increases (from 2°C of 6°C) in its World Energy Outlook (WEO). Some take into account either only current policies (Current Policies Scenario) or current and future policies and targets announced by governments to reduce greenhouse gas emissions (Stated Policies Scenario). The Sustainable Development Scenario specifies a temperature target - to limit the rise in long-term average global temperature (with a likelihood of 50%) to 2°C – and achieve elements of the UN Sustainable Development agenda, including energy access, air quality and climate objectives
- The IPCC reports, including the special report on 1.5°C, provide the scientific base for most organisations developing scenarios. In their Fifth Assessment Report (2014), they identify four Representative Concentration Pathways and greenhouse gas concentration trajectories based on more than 1,000 scenarios that have been published and peer-reviewed
- Other scenarios are available from organisations such as the Potsdam Institute for Climate Impact Research, Greenpeace International and International Renewable Energy Agency (IRENA)

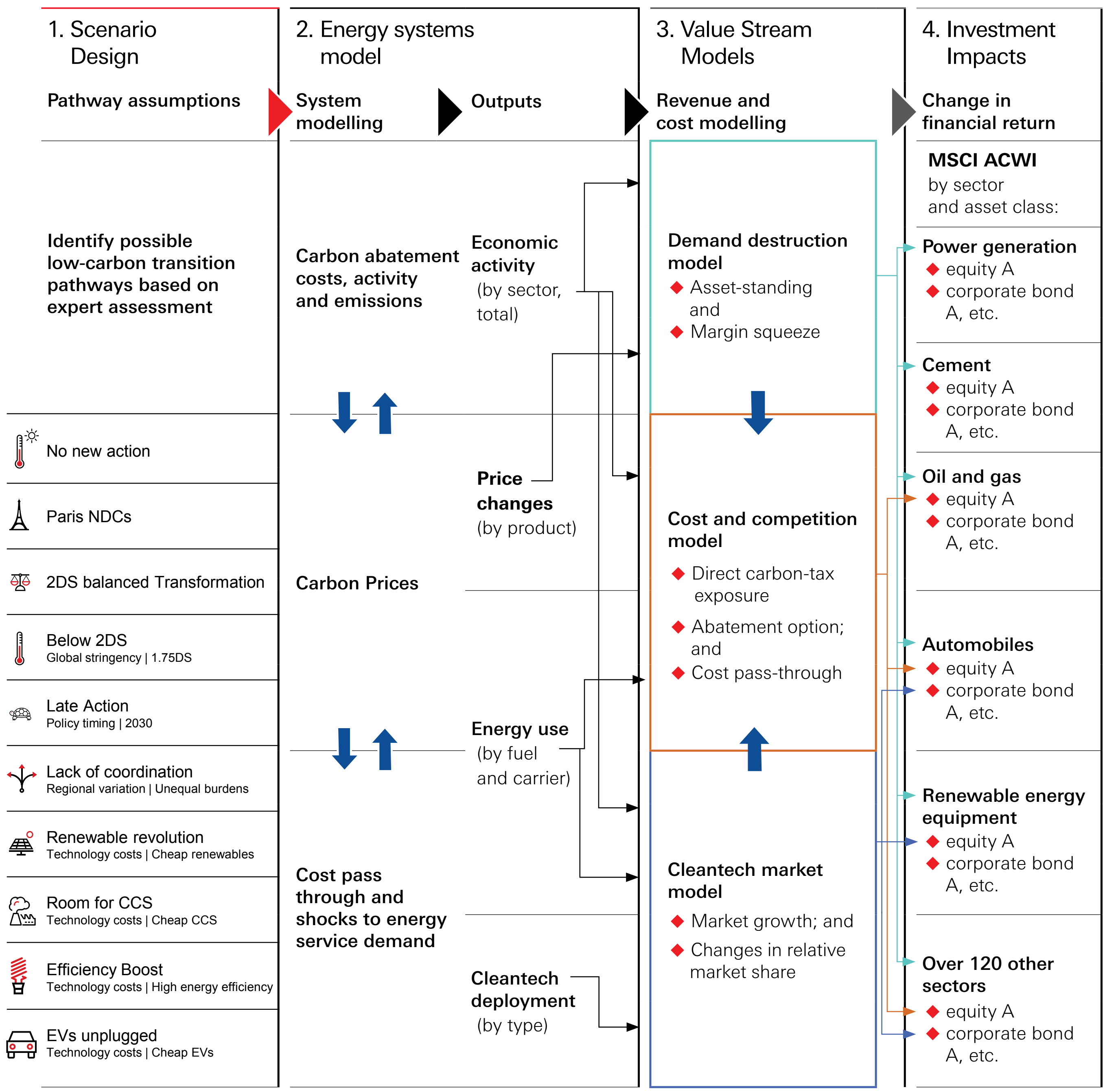
Scenarios or forecasts – The inevitable policy response

The PRI has recently convened the Inevitable Policy Response (IPR) consortium to build a Forecast Policy Scenario (FPS). The IPR project forecasts a response by 2025 that will be forceful, abrupt and disorderly because of delayed policy action to date. It is based on a forecast view of the policy and technology developments that are most likely to emerge, including views on:

- **Coal phase out –** with early coal phase-out for first mover countries by 2030 and a steady decline thereafter
- **Internal combustion engine (ICE) sales bans –** with early sales bans for first mover countries by 2035 and very low stock of ICE vehicles globally by 2050
- **Carbon pricing –** prices of USD40-60 tonnes CO2 by 2030 for first movers and global convergence to greater than or equal to USD100/tonnes CO2 by 2050
- **Carbon Capture & Storage (CCS) and industry decarbonisation –** limited CCS uptake to 2050 and CCS primarily for industry
- **Zero-carbon power –** including an increase in nuclear capacity and bioenergy crops
- **Energy efficiency –** an increase in coverage and stringency for examples through performance standards or utility obligation programmes
- **Land-use based greenhouse gas removal –** including the end of deforestation and expansion of reforestation and afforestation
- **Development in agriculture –** including continued improvements in agricultural yields and a steady growth in irrigation

Appendix 2: Overview of the low-carbon transition scenario analysis framework

The four-step approach, developed together with Vivid Economics, is outlined below. First, analysis of ten scenarios explores how future policy and technology uncertainty might shape the transition. Second, an energy system model translates scenario assumptions into levels of economic activity, price changes, energy use and cleantech deployment. Third, modelling of company value streams captures key dynamics affecting company performance, such as emissions abatement, cost pass through and changes in demand for emission intensive and cleantech products. Finally, a consolidated entity level dataset on climate-related risk and opportunity metrics is used to quantify potential changes in equity valuation and corporate debt credit ratings.



Source: HSBC Global Asset Management/Vivid Economics.

Appendix 3: Value stream models – additional detail

Cost and competition

Cost and competition assesses the supply-side impact of implicit carbon pricing on corporations, through the impact of carbon taxation on a firm's investment, production, price setting and market exit decisions. Supply-side carbon cost shocks represent the most direct, or immediate, impact mechanism for climate policy. Firms can respond to carbon taxation by investing in greenhouse gas abatement options to lower emissions, passing cost increases through to consumers as price hikes, absorbing cost increases and accepting lower profits, or in extreme cases, exiting markets. Cost and competition models these effects at the company-level using data on current emissions, abatement potential and cost as well as other economic factors. Outputs from cost and competition are used to assess the competition dynamics between companies in over 800 product markets.

The model identifies the key mechanisms and factors that determine company and sectorial vulnerability or resilience to carbon taxation policies. Measures such as carbon footprints or carbon price pathways do not provide sufficiently detailed assessments of company or sectorial exposure to carbon pricing policies. Emissions-intensive sectors with high abatement potential, power, for instance, could fare better than sectors with lower emissions-intensities but less abatement potential, such as iron and steel or cement. Cost pass through rates also vary by sector – industries with captive markets will outperform those serving consumers who are highly responsive to price changes. Relative emissions intensity is a key determinant of performance at the company level. For example, a clean cement company could outperform an emissions-intensive food processing company, even if the former has a higher absolute emissions intensity than the latter.

Empirical evidence on abatement costs and potential and cost pass-through rates is variable, although incorporating recent trends into cost projections suggests there is potential in hard-to-abate-sectors. Evidence on abatement potential and costs through the electrification of road freight transport suggests that opportunities have grown considering recent cost trends and technological breakthroughs, although considerable barriers remain for both technologies. Empirical evidence on cost pass-through in the EU Emissions Trading Scheme suggests ranges of around 0.6 – 1, which is aligned with the bottom-up modelling of cost pass-through rates within the cost and competition model itself.

The cost and competition model accounts for product differentiation, competitiveness and price elasticity of demand but does not differentiate between regulated and unregulated markets. It is uncertain how companies operating in regulated markets would be impacted differently from those operating in unregulated markets. On the one hand, the regulator may allow regulated companies, such as water utilities, to raise prices in response to carbon pricing. This would suggest high cost pass through rates and limited value impacts. However, some regulators might be reluctant to allow any price increases, which would mean that the regulated company would have to carry the full carbon price without ability to pass through any costs to consumers. Market specific insight into regulator behaviour is therefore required to understand how carbon pricing might affected regulated companies.

Fossil fuel demand destruction

Demand destruction estimates the effect of lower global output for fossil fuels on corporates involved in the associated extraction and production processes. Climate policies such as implicit carbon pricing raise the costs associated with consuming a barrel of oil, tonne of coal or cubic metre of natural gas. The consumer carbon cost wedge introduced between the producer and consumer prices lowers demand for each product to different degrees, depending on the size of the consumer carbon cost itself, and the characteristics of product demand. These effects are captured across the global economy in the scenario modelling stage. Company-level impacts can be decomposed into asset stranding and lower profit margins.

To assess the company-level implications of this fall in output, the demand destruction model uses a detailed analysis of the individual wells, fields and mines that make up the global supply of fossil fuels. Impacts on individual producers vary from sector average impacts of falling output, due to differences in costs of production, initial profit margins, portfolio composition and time horizons. Demand destruction builds out global supply curves for each fossil fuel, based on the average cost of production from each asset, and the merit order (ordering each productive asset from cheapest to most expensive). Global prices, asset-level production and profit margins are then estimated under each low-carbon transition scenario. This includes all companies identified as having product revenue in oil and gas production even if their primary industry is not categorised as oil and gas or coal.

The demand destruction analysis therefore also incorporates impacts for multi-activity companies such as diversified mining, metals and petroleum companies.

The demand destruction component identifies changes in cost and profit flows for each company in exposed sectors under different low-carbon transition scenarios. Companies make decisions to produce from existing and planned wells and fields based on the economic viability of each productive asset within the climate scenario in question.

The approach to estimating value-at-risk in fossil fuel producing sectors taken here differs to approaches in the literature by focussing on profit impacts. Commonly cited approaches focus on stranded assets, calculating the fall in production volumes or the level of uneconomical capital expenditure affecting corporations. Our approach instead focuses on the future profitability of fossil fuel extraction. Our approach also differs from looking only at capital at risk, as these approaches do not assess the impact of climate scenarios on the actual profitability of exploration and production activities. Our demand destruction model results suggest this is a key source of exposure, with two-thirds of profit losses attributable to lower profit margins across continued operations.

Green upside

This model estimates the impact of higher demand for goods with emissions abatement potential on companies producing these goods. Company-level impacts depend on current market share and share of green intellectual property (IP). Climate policies such as carbon pricing raise the costs associated with using emissions-intensive assets such as fossil-fired power plants and internal combustions engine (ICE) vehicles. This leads to an increase in demand for low or zero emissions substitutes such as wind turbines, solar panels and electric vehicles (EVs).

The cleantech model is based on global competition between companies for market share, with innovation potential the mechanism behind changes in market share. High-levels of relevant IP are expected to have higher market shares than those with little or no IP. Sectors covered by the model are wind turbines, solar panels, hydroelectric power generation equipment, EV and battery cell manufacturing, EV mineral production (lithium) and biofuels. Each of these sectors is modelled at the global-level, reflecting data constraints on current green revenues by region.

Model assumptions are conservative on the role of IP in future market share – a 15-year time to market horizon is used based on innovation lifecycles to determine the rate of convergence to future market share based on IP. The scope for IP market shares to change future revenue market shares is also limited to account for the range of other factors that affect future market share, as well as uncertainty around the relationship between IP today and market share tomorrow.

Fixed income impacts

Corporate debt impacts are estimated using changes in fixed income instrument credit ratings based on the Altman Z-score. Historical data on credit rating risk factors is combined with company estimates of cash flows to estimate changes in the Altman Z-score and credit ratings under each low-carbon transition scenario. As with equities, the ‘Paris NDCs’ scenario, under which countries implement Paris Agreement NDCs but no further policies, is taken as the ‘baseline’ scenario. All results are based on fixed income instruments issued by constituents of the MSCI All Countries World Index, and based on credit rating changes incorporating impacts out to 2050, unless stated otherwise.

Appendix 4: Scenarios – additional detail

Across all scenarios, we assume countries follow their Paris NDC commitments until new policy regimes comes into effect, in either 2020 or 2030. The carbon budgets and stringency levels under these scenarios were aligned with the latest climate research findings from the IPCC's 1.5°C Special Report[7]. Emissions budget units are GtCO2 between 2018 and 2100 for CO2 emissions only, (a separate allowance is made for non-CO2 emissions under the scenario runs used to calculate the IPCC budgets). All temperature scenarios used in this report have a probability of 50%. Standard modelling assumptions around population and GDP assumptions are taken from the IPCC's SSP2, and used as the default socioeconomic assumptions for all scenarios.

Caution is required when comparing results set out in this report against those reported in the October 2018 report. Results from the two publications are not directly comparable due to three main changes:

1. **Carbon budgets:**
   Emissions budgets associated with achieving relevant climate targets have been updated to reflect recent changes in climate science from IPCC 1.5º Special Report. Laxer emissions budgets tend to reduce the economic and financial costs of achieving a given level of warming
2. **Technology costs:**
   Scenarios used in this report have been updated to include the most up-to-date information on the costs of low-carbon transition technologies – this is consistent with academic use of integrated assessment models (IAMs) and energy system models, which are constantly updated to reflect the latest trends in technology costs and deployment constraints. This affects both core scenarios through different central technology cost estimates and divergence technology scenarios through revised extremum cost estimates.
3. **Baseline scenario:**
   This report uses the Paris NDCs scenario as a baseline for comparing climate scenario outcomes, whereas the October 2018 report used a No Policy Action scenario. Paris NDCs represents a more stringent baseline climate policy action than No Policy Action – the climate scenario impacts relative to Paris NDCs presented in this report are expected to be smaller than those set out in the earlier report.

Scenarios used in this report compared to the October 2018 report scenarios

Scenario	Oct briefing note scenario	Summary of changes
No New Action	No Policy Action	Baseline technology costs
Paris NDCs	N/A	New scenario
2DS Balanced Transformation	2020 Action	Baseline technology costs, carbon budget
Below 2DS	N/A	New scenario
Late Action	2030 Action	Baseline technology costs, carbon budget
Lack of Coordination	N/A	New scenario
Renewable Revolution	Renewable Revolution	Baseline technology costs, carbon budget, technology cost changes from baseline
Room for CCS	CCS Storm	
Efficiency Boost	Efficiency Boost	
EVs Unplugged	N/A	New scenario

7 https://climateoutreach.org/resources/public-engagement-1-5c-ipcc-sr15/?gclid=EAIaIQobChMIs9yP5sOr5wIVR7DtCh33TQ6YEAAYASAAEgJdTvD_BwE

Appendix 5: Technical details and assumptions from TIAM

TIAM-Grantham, the TIMES Integrated Assessment Model, developed by Imperial College London is used to translate the assumptions under each low-carbon transition scenario into variables for the value stream models. The TIAM-Grantham model has been subject to significant academic scrutiny, and is similar to the models used by the IEA as part of its World Energy Outlook (WEO) and Energy Technology Perspectives (ETP) publications. TIAM models only energy sector emissions and does not cover land use or process emissions – a conservative allowance of 230GtCO2 is made for these emissions sources from 2018 – 2100. TIAM solves using the remaining energy systems' carbon budget out to 2100. Along all 7 2DS scenarios and the Below 2DS scenario, emissions peak in the year climate policy comes into play.

Granularity: thousands of individual technologies are included over 16 regions and 5 energy end-use sectors:

- An example of an individual technology in TIAM is ground-source heat pumps (GSHPs), which provide space heating and cooling services for residential and commercial buildings space – for each such technology, energy efficiency, asset lifetime, emissions intensity, investment and operational cost estimates are used by the model
- The 16 regions are Africa, Australia and New Zealand, Canada, China, Central and South America, Eastern Europe, Former Soviet Union, India, Japan, Middle East, Mexico, Other developing Asia, South Korea, United States, Western Europe and the United Kingdom
- The 5 energy end-use sectors are agriculture, industry, commercial buildings, residential buildings and transport

Modelling scope and horizon:

- The model time horizon is 2018 – 2100, with the carbon budget satisfied by the end-point of 2100
- Non-energy sector emissions are not modelled by TIAM, with an allowance set for these outside of the model depending on the overall emissions budget – this covers process emissions and emissions from changes in land use

Calibration:

- 'Baseline' parameters for all scenarios are calibrated using the No Policy Action scenario
- All scenarios follow the Paris NDCs scenario until the new policy regime associated with individual climate scenarios comes into effect

Author – Stephanie Maier

Stephanie Maier is a Director – Responsible Investment Specialist in London and has been working in the financial industry since 2001. Prior to joining HSBC in 2017, Stephanie worked as Head of Responsible Investment Strategy and Research for Aviva Investors. Prior to this, Stephanie worked at EIRIS (now VigeoEIRIS), where she was Head of Research. Stephanie holds a BA (Hons) in Biological Sciences from Oxford University, a MSc (Distinction) in Environmental Technology from Imperial College and the Investment Management Certificate (IMC). Stephanie is also on the Boards of the Aldersgate Group and the UK Sustainable Investment and Finance Association (UKSIF) and Chair of the Institutional Investors Group on Climate Change (IIGCC) Corporate Programme. She sits on the Steering Committee of the global ClimateAction100+ investor initiative.

About Vivid Economics – Vivid Economics is a leading strategic economics consultancy with global reach focussing on government and the private sector, and for society at large.

Important information

For Professional Clients and intermediaries within countries set out below; and for Institutional Investors and Financial Advisors in Canada and the US. This document should not be distributed to or relied upon by Retail clients/investors.

The value of investments and the income from them can go down as well as up and investors may not get back the amount originally invested. Past performance contained in this document is not a reliable indicator of future performance whilst any forecasts, projections and simulations contained herein should not be relied upon as an indication of future results. Where overseas investments are held the rate of currency exchange may cause the value of such investments to go down as well as up. Investments in emerging markets are by their nature higher risk and potentially more volatile than those inherent in some established markets. Economies in Emerging Markets generally are heavily dependent upon international trade and, accordingly, have been and may continue to be affected adversely by trade barriers, exchange controls, managed adjustments in relative currency values and other protectionist measures imposed or negotiated by the countries with which they trade. These economies also have been and may continue to be affected adversely by economic conditions in the countries in which they trade. Mutual fund investments are subject to market risks, read all scheme related documents carefully.

The contents of this document may not be reproduced or further distributed to any person or entity, whether in whole or in part, for any purpose. All non-authorised reproduction or use of this document will be the responsibility of the user and may lead to legal proceedings. The material contained in this document is for general information purposes only and does not constitute advice or a recommendation to buy or sell investments. Some of the statements contained in this document may be considered forward looking statements which provide current expectations or forecasts of future events. Such forward looking statements are not guarantees of future performance or events and involve risks and uncertainties. Actual results may differ materially from those described in such forward-looking statements as a result of various factors. We do not undertake any obligation to update the forward-looking statements contained herein, or to update the reasons why actual results could differ from those projected in the forward-looking statements. This document has no contractual value and is not by any means intended as a solicitation, nor a recommendation for the purchase or sale of any financial instrument in any jurisdiction in which such an offer is not lawful. The views and opinions expressed herein are those of HSBC Global Asset Management at the time of preparation, and are subject to change at any time. These views may not necessarily indicate current portfolios' composition. Individual portfolios managed by HSBC Global Asset Management primarily reflect individual clients' objectives, risk preferences, time horizon, and market liquidity. Foreign and emerging markets. Investments in foreign markets involve risks such as currency rate fluctuations, potential differences in accounting and taxation policies, as well as possible political, economic, and market risks. These risks are heightened for investments in emerging markets which are also subject to greater illiquidity and volatility than developed foreign markets. This commentary is for information purposes only. It is a marketing communication and does not constitute investment advice or a recommendation to any reader of this content to buy or sell investments nor should it be regarded as investment research. It has not been prepared in accordance with legal requirements designed to promote the independence of investment research and is not subject to any prohibition on dealing ahead of its dissemination.

We accept no responsibility for the accuracy and/or completeness of any third party information obtained from sources we believe to be reliable but which have not been independently verified.

HSBC Global Asset Management is a group of companies in many countries and territories throughout the world that are engaged in investment advisory and fund management activities, which are ultimately owned by HSBC Holdings Plc. (HSBC Group). HSBC Global Asset Management is the brand name for the asset management business of HSBC Group. The above communication is distributed by the following entities:

- In Argentina by HSBC Global Asset Management Argentina S.A., Sociedad Gerente de Fondos Comunes de Inversión, Agente de administración de productos de inversión colectiva de FCI N°1
- In Australia, this document is issued by HSBC Bank Australia Limited ABN 48 006 434 162, AFSL 232595, for HSBC Global Asset Management (Hong Kong) Limited ARBN 132 834 149 and HSBC Global Asset Management (UK) Limited ARBN 633 929 718. This document is for institutional investors only, and is not available for distribution to retail clients (as defined under the Corporations Act). HSBC Global Asset Management (Hong Kong) Limited and HSBC Global Asset Management (UK) Limited are exempt from the requirement to hold an Australian financial services license under the Corporations Act in respect of the financial services they provide. HSBC Global Asset Management (Hong Kong) Limited is regulated by the Securities and Futures Commission of Hong Kong under the Hong Kong laws,

which differ from Australian laws. HSBC Global Asset Management (UK) Limited is regulated by the Financial Conduct Authority of the United Kingdom and, for the avoidance of doubt, includes the Financial Services Authority of the United Kingdom as it was previously known before 1 April 2013, under the laws of the United Kingdom, which differ from Australian laws

- in Austria by HSBC Global Asset Management (Österreich) GmbH which is regulated by the Financial Market Supervision in Austria (FMA)
- in Bermuda by HSBC Global Asset Management (Bermuda) Limited, of 37 Front Street, Hamilton, Bermuda which is licensed to conduct investment business by the Bermuda Monetary Authority
- in Canada by HSBC Global Asset Management (Canada) Limited which provides its services as a dealer in all provinces of Canada except Prince Edward Island and also provides services in Northwest Territories. HSBC Global Asset Management (Canada) Limited provides its services as an advisor in all provinces of Canada except Prince Edward Island
- in Chile: Operations by HSBC's headquarters or other offices of this bank located abroad are not subject to Chilean inspections or regulations and are not covered by warranty of the Chilean state. Further information may be obtained about the state guarantee to deposits at your bank or on www.sbif.cl
- in Colombia: HSBC Bank USA NA has an authorized representative by the Superintendencia Financiera de Colombia (SFC) whereby its activities conform to the General Legal Financial System. SFC has not reviewed the information provided to the investor. This document is for the exclusive use of institutional investors in Colombia and is not for public distribution
- in Finland, Norway, Denmark and Sweden by HSBC Global Asset Management (France), a Portfolio Management Company authorised by the French regulatory authority AMF (no. GP99026) and through the Stockholm branch of HSBC Global Asset Management (France), regulated by the Swedish Financial Supervisory Authority (Finansinspektionen)
- in France, Belgium, Netherlands, Luxembourg, Portugal, Greece by HSBC Global Asset Management (France), a Portfolio Management Company authorised by the French regulatory authority AMF (no. GP99026)
- in Germany by HSBC Global Asset Management (Deutschland) GmbH which is regulated by BaFin;
- in Hong Kong by HSBC Global Asset Management (Hong Kong) Limited, which is regulated by the Securities and Futures Commission
- in India by HSBC Asset Management (India) Pvt Ltd. which is regulated by the Securities and Exchange Board of India
- in Italy and Spain by HSBC Global Asset Management (France), a Portfolio Management Company authorised by the French regulatory authority AMF (no. GP99026) and through the Italian and Spanish branches of HSBC Global Asset Management (France), regulated respectively by Banca d'Italia and Commissione Nazionale per le Società e la Borsa (Consob) in Italy, and the Comisión Nacional del Mercado de Valores (CNMV) in Spain
- in Mexico by HSBC Global Asset Management (Mexico), SA de CV, Sociedad Operadora de Fondos de Inversión, Grupo Financiero HSBC which is regulated by Comisión Nacional Bancaria y de Valores
- in the United Arab Emirates, Qatar, Bahrain & Kuwait by HSBC Bank Middle East Limited which are regulated by relevant local Central Banks for the purpose of this promotion and lead regulated by the Dubai Financial Services Authority
- in Oman by HSBC Bank Oman S.A.O.G regulated by Central Bank of Oman and Capital Market Authority of Oman
- in Peru: HSBC Bank USA NA has an authorized representative by the Superintendencia de Banca y Seguros in Perú whereby its activities conform to the General Legal Financial System - Law No. 26702. Funds have not been registered before the Superintendencia del Mercado de Valores (SMV) and are being placed by means of a private offer. SMV has not reviewed the information provided to the investor. This document is for the exclusive use of institutional investors in Perú and is not for public distribution
- in Singapore by HSBC Global Asset Management (Singapore) Limited, which is regulated by the Monetary Authority of Singapore
- in Switzerland by HSBC Global Asset Management (Switzerland) AG whose activities are regulated in Switzerland and which activities are, where applicable, duly authorised by the Swiss Financial Market Supervisory Authority. Intended exclusively towards qualified investors in the meaning of Art. 10 para 3, 3bis and 3ter of the Federal Collective Investment Schemes Act (CISA)
- in Taiwan by HSBC Global Asset Management (Taiwan) Limited which is regulated by the Financial Supervisory Commission R.O.C. (Taiwan)
- in the UK by HSBC Global Asset Management (UK) Limited, which is authorised and regulated by the Financial Conduct Authority
- and in the US by HSBC Global Asset Management (USA) Inc. which is an investment adviser registered with the US Securities and Exchange Commission

Investment Products:

- Are not a deposit or other obligation of the bank or any of its affiliates
- Not FDIC insured or insured by any federal government agency of the United States
- Not guaranteed by the bank or any of its affiliates
- Are subject to investment risk, including possible loss of principal invested

ED-1272– Exp 28/02/2021