

Investing in the low-carbon transition

# Low-carbon transition scenarios:

## Exploring scenario analysis for equity valuations

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

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# Foreword

As part of HSBC Global Asset Management's ongoing assessment of the implications of climate change for our investment strategies, we commissioned Vivid Economics to undertake this analysis, to ensure we better understand the potential implications of a range of climate change scenarios. The approach developed is designed to assist and inform our analysis going forward.

The transition to a lower carbon economy, consistent with limiting the global average increase in temperatures to just 2°C or the more ambitious 1.5°C above pre-industrial levels, presents both risks and opportunities for investors. The challenge, of course, is to identify and, if at all possible, quantify those risks and opportunities. While the imperative of the need to transition to a low-carbon economy is very clear, the nature of this transition is highly uncertain and it is this uncertainty which is probably the biggest challenge for investors.

The impact of the transition to a low-carbon economy on companies, the financial markets and investors is likely to depend on the 'transition pathway'. Key questions concern the nature of climate policy, along with the timing of policy action, and the evolution and application of available technologies. One way of understanding the potential outcomes we might face is to develop scenarios based on these uncertainties and then to model the likely implications of each for sectors and companies.

With this in mind, over the past several months HSBC Global Asset Management has worked with Vivid Economics to analyse a number of different transition pathways and to begin to understand the potential investment implications of each of these scenarios.

This report focuses on six plausible transition scenarios, examining the impact of 'slower' versus 'faster' policy action, and of three different technology pathways. Having modelled the revenue and cost impacts at the individual company level, a simple Discounted Cash Flow (DCF) model has been used to develop a broad sense of how companies in the MSCI All Country World Index might 'perform' in each scenario.

While, inevitably, a number of simplifying assumptions are needed to perform this analysis, its power lies in the fact that it has produced results for a very large number of companies, in a consistent way, across scenarios. One immediate benefit of this is that it is possible to identify which sectors and companies are likely to perform relatively well in which scenarios.

Most readers are likely to find the results fairly intuitive, but it is worth noting that results suggest variation in impacts within sectors may be as important as that between some sectors, confirming the importance of understanding company-level impacts as we transition to a lower carbon economy.

The analysis presented in this paper is simply a first step towards an understanding of the investment environment we are likely to face over the next decade and beyond, as we seek to get to grips with the profound challenges presented by climate change. There is a great deal to think about, but I hope this paper provides you with a taster of the kind of work which is needed.

**Chris Cheetham, Global Chief Investment Officer,  
HSBC Global Asset Management.**

# Executive summary

**Climate change is one of the greatest challenges of the 21st century, and achieving a low-carbon transition could involve disruptive, structural changes in the economy and in financial markets.** In recognition of this challenge, 181 countries have ratified the Paris Agreement, representing 89% of global CO<sub>2</sub> emissions.<sup>1</sup> Climate regulation has already begun to impact financial markets, and the stringency and coverage of climate action is expected to increase. The number of carbon-pricing schemes launched globally has doubled since 2012.<sup>2</sup>

**How to invest in a transitioning economy is a key challenge for investors.** Investors recognise that the transition to a low-carbon economy entails risks and opportunities, with over 300 companies and investors supporting the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD). However, poor data quality and availability, underdeveloped analyses of possible low-carbon transition scenarios, and a lack of granular models for estimating upside and downside exposure remain critical issues for investors.

The analysis presented is for the financial impacts of low-carbon transition policy and technology risk only – the physical risks from climate change are not considered here. All analysis in this paper is based on economic impacts from 2018 to 2050.

**To overcome some of these challenges, this report illustrates a scenario-based approach to assess the economic impacts of a low-carbon transition, including uncertainty around future policy and technology pathways.** This report uses six illustrative scenarios to explore how policy timing and future technology costs influence economic outcomes:

## Policy Timing: Future Technology Costs (while maintaining 2020 Action scenario policy assumptions):

- **No Policy Action-** provides a baseline reflecting existing climate policies and predicted technology cost trends, with no further policy changes
- **2020 Action-** Policy change from 2020 which has at least a 50% chance of limiting warming to 2°C
- **2030 Action-** Policy change from 2030 which has at least a 50% chance of limiting warming to 2°C
- **Renewable Revolution-** Reduced costs for solar and wind energy
- **CCS Storm-** Reduced costs for Carbon Capture and Storage, a technique to reduce atmospheric greenhouse gas concentrations
- **Efficiency Boost-** Increases in energy productivity

<sup>1</sup> The United States is included in these figures; the earliest it could leave the Paris Agreement is 4 November 2020 <https://unfccc.int/process/the-paris-agreement/status-of-ratification> as at September 2018

<sup>2</sup> Number of planned or operational carbon pricing schemes; World Bank 2017 <http://www.worldbank.org/en/results/2017/12/01/carbon-pricing>

<sup>3</sup> Clean technologies included in this analysis are wind, solar and hydro power generation equipment, production of biofuels and EVs (in three separate markets: vehicles, batteries and minerals for batteries)

**Across all the scenarios, initial findings suggest that a transition to 2°C will have significant impacts on net present value profits at the sector and equity level versus a world in which there is no new policy action.** Variation in sector-level impacts is large. For example, oil and gas equities lose c.30-35% following these scenarios and modelling approach, while renewable energy companies gain c.70% in the 2020 Action scenario, where climate action increases rapidly from 2020. In addition, this analysis suggests that within-sector variation in impacts across companies can also be large. For exposed sectors, such as power generation, energy-intensive industries or oil and gas, within-sector variation can be many times greater than differences in average impacts across sectors. This suggests there will be absolute 'climate winners' even in emissions-intensive sectors that face negative overall value impairment.

**The six illustrative scenarios further highlight the risk associated with policy and technology uncertainty.** For example, oil and gas equities lose c.40% in a scenario with rapid penetration of renewables but only c.25% in a scenario with rapid deployment of Carbon Capture and Storage (CCS), while renewable energy equipment companies gain c.130% versus only c.10% across the same scenarios. Nevertheless, index-level impacts across the six illustrative climate action scenarios are modest, with a c.2% fall in the MSCI ACWI in the 2020 Action scenario. This is due to the relatively small share of highly-exposed sectors in the overall index, as well as some offsetting effect from emerging green opportunities. It suggests that a diversified portfolio could be resilient to climate action risk, although the analysis does not fully incorporate the possible impact of scenarios on macro-economic growth.



# 1. Introduction

The low-carbon transition presents financial risks and opportunities. This report presents one approach for assessing exposure and impacts

## Low-carbon investment today

**Climate change is one of the greatest challenges of the 21st century, with momentum building for governments, businesses and consumers to act decisively to reduce emissions to limit the increase in global average temperatures to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels.** Since the Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report, warnings of the 'severe, pervasive and irreversible impacts' of continued global warming have been noted by policymakers, who show an increasing appetite for action to reduce greenhouse gas (GHG) emissions.<sup>4</sup> 181 countries have now ratified the Paris Agreement, representing 89% of global CO<sub>2</sub> emissions.<sup>5</sup> The stringency and coverage of climate policy is expected to increase; for example, the number of carbon pricing schemes has doubled since 2012.<sup>6</sup>

At the same time, there are increasing signs of a pervasive business response and associated wave of disruptive innovation. The cost of electricity from solar PV fell by over 70% between 2010 and 2017,<sup>7</sup> while lithium-ion battery prices have fallen by almost 80% over the same period.<sup>8</sup>

**Achieving a low-carbon transition which limits temperature increases to well below 2°C will involve disruptive, structural changes in the economy, with near-, mid- and long-term implications for financial assets.** One prominent example is the falling value of German utilities since 2000, driven in part by a shift away from nuclear and extensive government support for renewables. Wholesale electricity prices plummeted, and conventional utilities incurred significant losses.

4 Climate Change 2014 Synthesis Report, 2014, IPCC,

[http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR\\_AR5\\_FINAL\\_full\\_wcover.pdf](http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf)

5 The United States is included in these figures; the earliest it could leave the Paris Agreement is 4 November 2020 <https://unfccc.int/process/the-paris-agreement/status-of-ratification>

6 Number of planned or operational carbon pricing schemes; World Bank 2017

<http://www.worldbank.org/en/results/2017/12/01/carbon-pricing>

7 Renewable Power Generation Costs in 2017, IRENA 2018

[http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA\\_2017\\_Power\\_Costs\\_2018.pdf](http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_2017_Power_Costs_2018.pdf)

8 Tumbling Costs for Wind, Solar, Batteries Are Squeezing Fossil Fuels, Bloomberg NEF 2018

<https://about.bnef.com/blog/tumbling-costs-wind-solar-batteries-squeezing-fossil-fuels/>



RWE and E.ON recorded a fall in market cap of 59% and 65% respectively over the period 2000-15, with E.ON's largest ever losses in 2015 after significant write-downs on its coal- and gas-fired plants.<sup>9</sup> Similarly in the cleantech sector, Tesla and Vestas offer prominent examples. Tesla's average market cap rose by 105% from 2014 to 2018, putting it among the most highly-valued automotive companies in the world.<sup>10</sup> On the other hand, Vestas has seen a full boom-bust-boom cycle in its market cap, with a peak in 2008 followed by a 95% decline to late 2012, and a recovery to c.70% of its peak value to date.<sup>11</sup> While valuations are a response to a combination of idiosyncratic factors, climate policy, technological developments, and associated expectations about the transition pathway played a role in such large shifts in the value of these companies.

**To encourage greater transparency around the risks related to climate change, the TCFD has developed voluntary financial disclosure standards for climate-related risks and opportunities.** Over 300 companies have already endorsed the TCFD recommendations, including 150 financial institutions with a combined market capitalisation of over USD6 trillion.<sup>12</sup> At the country level, two thirds of G20 member states are actively engaged with the TCFD, with France already having made climate change-related reporting mandatory for institutional investors.<sup>13</sup> The TCFD has also recommended that scenario analysis be used to assess the range of climate impacts, due to the considerable uncertainty around their precise timing and magnitude.

**However, data challenges remain as climate-related corporate financial data is often of poor quality or incomplete in its coverage.** Disclosures on climate metrics are not always available and even when companies do disclose, data may not be accurate.<sup>14</sup> Information on other risks, such as market risk driven by changes in supply or demand, is difficult to find or unavailable from consolidated sources. Climate-related opportunity metrics are a more recent development, with emerging offerings such as FTSE Russell's Green Revenue data series improving the evidence base for investors.

**In addition to better disclosure, investors need to develop a diverse set of approaches for quantifying the financial impacts of a low-carbon transition.** Conventional portfolio management tools such as mean-variance analysis rely on historical relationships, which make them useful in stable policy and market environments. However, they will not capture structural breaks such as the low-carbon transition. Publicly available scenarios do not currently adequately explore the range of uncertainty around when we transition, and what the transition might look like, nor do they provide a coherent framework for translating those scenarios into company-level investment impacts.

9 Financial Times 2016 <https://www.ft.com/content/b5fffac6-e5c5-11e5-ac45-5c039e797d1c>

10 Stock information for Tesla Inc based on share price on 03/09/2018 <http://ir.tesla.com/stock-information> 11 Stock information for Vestas Wind Systems A/S based on share price on 03/09/2018 <https://www.vestas.com/en/investor/share#!share-performance>

12 An asset owner's guide to the TCFD recommendations, Principles for Responsible Investment

<https://www.unpri.org/download?ac=4652> 13 Sailing from different harbours: G20 approaches to implementing the recommendations of the Task Force on Climate-related Financial Disclosures. Cambridge, UK: the Cambridge Institute for Sustainability Leadership, 2018 <https://www.cisl.cam.ac.uk/publications/publication-pdfs/cisl-tcf-d-report-2018.pdf>

14 Portfolio carbon data: the quality imperative, Trucost 2015 <https://www.trucost.com/publication/portfolio-carbon-data-quality-imperative/>; Trucost's primary universe comprises 6,000 of the largest listed companies globally.

## 2. Low-carbon transition scenarios

Scenario analysis is a powerful way to explore policy and technology uncertainties within the low-carbon transition, which can present key sources of risk for investors

Scenarios are vital to assessing the range of risks and opportunities investors face, given the considerable uncertainty around the low-carbon transition. There is no consensus on how climate policy, market conditions and relative technology costs will evolve across the world. Instead, scenarios can highlight plausible, distinctive and relevant pathways investors can use to understand portfolio impacts. By assessing the potential implications of a range of plausible future states, scenario analysis forms a cornerstone of the TCFD recommendations.<sup>15</sup>

To illustrate the importance of testing different scenarios, this report looks at two critical axes of uncertainty – the timing of action and the technology pathway of the transition.

### Policy Timing:

- **No Policy Action**- provides a baseline reflecting existing climate policies and predicted technology cost trends, with no further policy changes
- **2020 Action**- Policy change from 2020 which has at least a 50% chance of limiting warming to 2°C
- **2030 Action**- Policy change from 2030 which has at least a 50% chance of limiting warming to 2°C

### Future Technology Costs (while maintaining 2020 Action scenario policy assumptions):

- **Renewable Revolution**- Reduced costs for solar and wind energy
- **CCS Storm**- Reduced costs for Carbon Capture and Storage, a technique to reduce atmospheric greenhouse gas concentrations
- **Efficiency Boost**- Increases in energy productivity

The scenarios chosen for this report are in line with the IEA Sustainable Development Scenario (SDS), as well as its earlier WEO 450 scenario. In comparison to the IPCC 1.5° Special Report (IPCC 1.5 SR) scenarios, the scenarios used here are in between IPCC scenarios for achieving 1.5° C with a 50-66% probability, and scenarios for achieving 2° C with a 50-66% probability. The 2020 and 2030 Action scenarios cover a ten-year range around the timing of action towards a 2°C pathway, allowing assessment of how policy timing might differentially affect equity market valuation.

Figure 1: Six illustrative 2°C scenarios are used to explore key policy and technology uncertainties

### Policy uncertainties Technology uncertainties

 <p><b>No Policy Action</b> No climate action beyond announced policies</p>	 <p><b>Renewable Revolution</b> Larger than expected reduction in solar and wind costs</p>
 <p><b>2020 Action</b> 2 degree aligned policy from 2020 onwards</p>	 <p><b>CCS Storm</b> Larger than expected reduction in CCS cost</p>
 <p><b>2030 Action</b> 2 degree aligned policy from 2030 onwards</p>	 <p><b>Efficiency Boost</b> Larger than expected increase in energy productivity</p>

Note: All non-technology uncertainty scenarios are based on best available technology cost estimates.

Source: Scenario design method developed by Vivid Economics/HSBC Global Asset Management.

<sup>15</sup> Recommendations of the Task Force on Climate-related Financial Disclosures, TCFD, 2017  
<https://www.fsb-tcf.org/wp-content/uploads/2017/06/FINAL-TCFD-Report-062817.pdf>



The scenarios set out in Figure 1 have been produced using Imperial College London’s TIMES Integrated Assessment Model (TIAM-Grantham).<sup>16</sup> TIAM is a global system model with a high degree of disaggregation, containing thousands of technologies, fourteen regions and five major energy end-use sectors. Although other modelling suites are available, TIAM has been subject to significant peer review, and offers a level of sectoral and regional detail critical to understanding company-level impacts. Fossil fuel use, renewable capacity, EV deployment, and many other economic indicators are modelled by minimising the cost of reducing emissions, subject to a carbon budget constraint, policy and technology cost assumptions. The 2020 Action scenario is based on the central technology cost assumptions and a 2020 start, with the 2030 Action scenario based on climate action not accelerating until 2030. The technology uncertainty scenarios involve changing the technology cost assumptions based on known sensitivity ranges. All analysis for this paper is based on modelling of the economic impacts from 2018 to 2050.

**Scenario analysis translates emissions reduction requirements into economic signals – effective carbon prices – that affect sectors and the wider economy.** A wide variety of policy mechanisms can be used to achieve emissions reductions, including carbon and fuel taxes, emissions trading schemes, energy efficiency and emissions performance standards, and border carbon adjustments. These policy mechanisms translate into an effective carbon price, with companies facing costs in proportion to their emissions. Throughout this report, the term ‘carbon price’ is used to refer to the economic signal resulting from a variety of emissions reduction measures: the effective carbon price. The analysis currently considers carbon prices at the global level. Regional variation will play an increasingly important role in the transition and will be explored in future analyses across more granular scenarios.

<sup>16</sup> The TIAM-Grantham model is the Grantham Institute at Imperial College London’s version of the ETSAP-TIAM model, which is developed and maintained by the International Energy Agency’s Energy Technology Systems Analysis Programme (ETSAP). For details on ETSAP: <https://iea-etsap.org/index.php/applications/global>

**Although the scenarios are illustrative, detailed scrutiny of modelling outputs suggests they provide logically-consistent forward-looking viewpoints that capture a good deal of variation in possible future outcomes.** In particular, it is useful to scrutinise the major economic impacts derived from the modelled scenarios. For this exercise, a series of diagnostics were conducted to ensure that modelling results are credible based on historical experience of major economic shifts at the aggregate, sector and technology level. In addition, scenarios are compared to other forward-looking perspectives, and subjected to a variety of ad hoc sense checks by the Vivid Economics team of experts.

**Consistent with expectations, the stringency of climate action to achieve a 2°C-aligned transition is reflected in high carbon prices across the illustrative 2°C scenarios relative to No Policy Action.** In addition, variation across scenarios is large, and results present a logical narrative for future pathways. While 2030 Action leads to lower carbon prices in the short term, it requires significantly stronger policy action after 2030, leading to the highest average carbon prices from now to 2050 of c.150-160 USD/tCO<sub>2</sub>.<sup>17</sup> Also aligned with expectations, different levels of technology cost affect the economy-wide cost of abatement and, as a result, the carbon price required to achieve the 2°C target (with at least a 50% probability). These scenarios lead to the lowest average carbon prices from now to 2050, with a range of c.80-90 USD/tCO<sub>2</sub> in the Renewable Revolution and CCS Storm scenarios. These ranges are consistent with a large body of scenarios produced by other modelling teams, including the IEA whose World Energy Outlook (WEO) 450 scenario implies an average carbon price to 2050 of c.110 USD/tCO<sub>2</sub>.

**Consistent with what the scenarios are designed to test, variation in sector-level demand is greatest in fossil fuel, carbon-intensive and cleantech sectors.** Coal demand over the period to 2050 is hit the hardest under all scenarios, and is particularly sensitive to policy timing and technology costs, falling by c.40% in the 2030 Action Scenario and by c.60-70% in the Renewable Revolution and Efficiency Boost scenarios.<sup>18</sup> Oil and gas demand are also impacted greatly, with declines of c.20-30% in 2030 Action and Renewable Revolution scenarios. Moreover, in the 2020 Action and Renewable Revolution scenarios, the models run by Vivid Economics show much smaller impacts on gas demand (ranging from a fall of c.10% to an increase of c.10%), since the role of gas as a transition fuel in these instances is greatly enhanced. Finally, with regards to cleantech, we observe large positive impacts under the 2°C-scenarios. For example, EV deployment grows by c.130% under the Renewable Revolution scenario and by c.70% under the Efficiency Boost scenario. Renewable deployment is more sensitive to technology cost, with deployment only c.60% higher in the CCS Storm, compared to the No Policy Action scenario, but c.280% higher under the Renewable Revolution scenario. This is consistent with renewables and CCS being, to a large degree, substitutes in the future low-carbon power sector.

<sup>17</sup> The average carbon prices are an average of annual carbon prices (explicit and implicit) across the years 2018-2050 as modelled in TIAM.

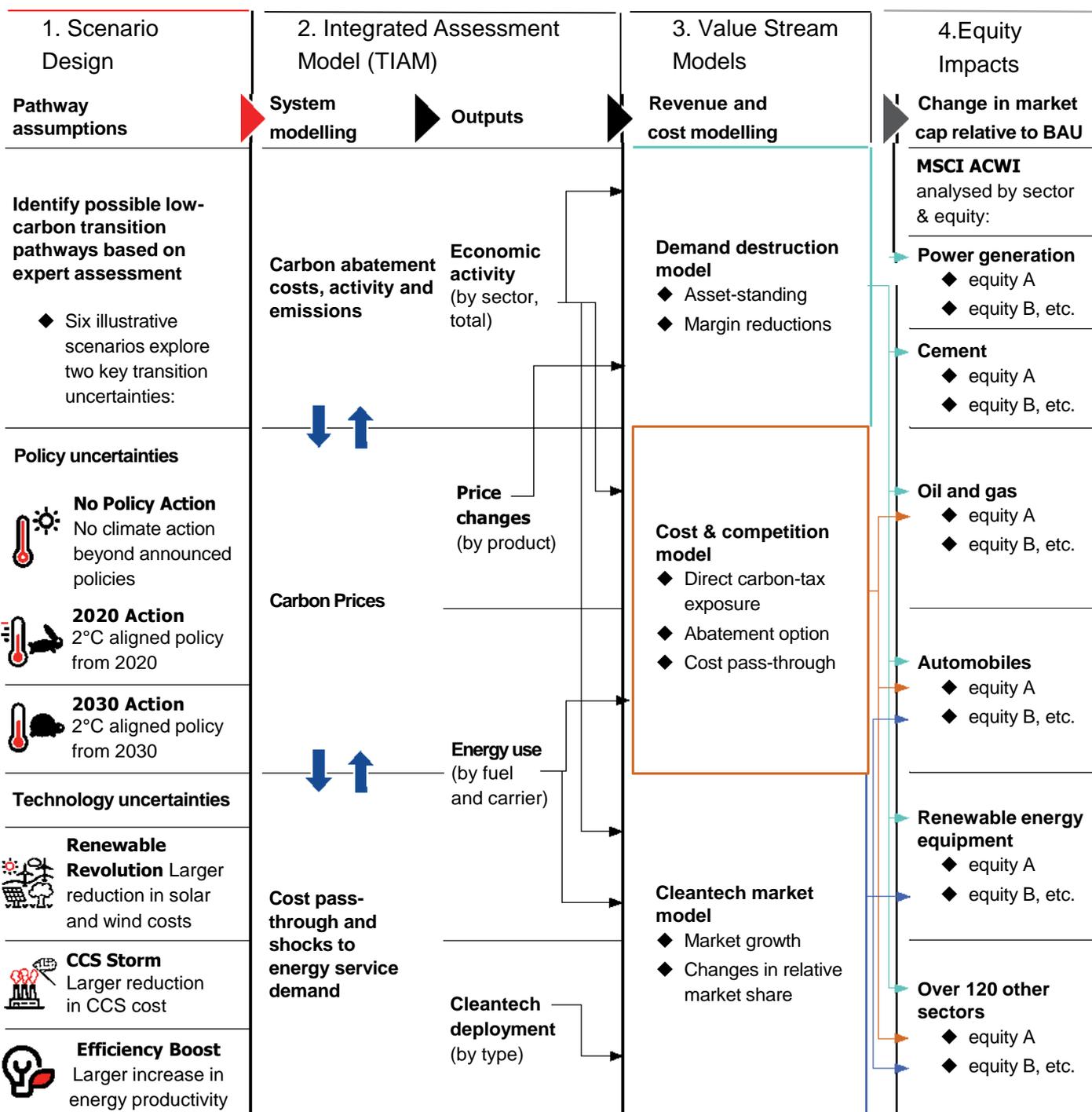
<sup>18</sup> Demand reductions (gains) in our 2°C-compliant scenarios represent the fall (gain) in total cumulative demand against the No Policy Action scenario across the years 2018-2050.

# 3. Modelling framework

This report presents the results of one approach to quantifying the financial impacts of a low-carbon transition in line with the upper warming goal of the Paris Agreement. The approach accounts for some of the most widely cited uncertainties, and incorporates dynamic economic interactions. In spite of significant information deficiencies, it seeks to provide insights into the fundamental nature of the risks and opportunities, which can be used to test investment decisions and to focus further scrutiny. For this report, we applied the approach to a diversified equity portfolio - the MSCI All Country World Index (ACWI).

The approach follows a four-step methodology for analysing the impacts of the low-carbon transition on a diversified equity portfolio (Figure 2).

**Figure 2: The approach combines scenario design, top-down integrated assessment modelling and bottom-up value stream modelling, to estimate equity impacts**



**1. Scenario design involves identifying the set of key variables and estimating both expected values and likely sensitivity around these assumptions.** Variables driving low-carbon scenarios include temperature-change targets and associated carbon budgets, climate-policy timing, and abatement costs both today and in the future. This report is based on six illustrative scenarios: a No Policy Action scenario, and five 2°C-aligned climate action scenarios.<sup>19</sup>

While future analysis could explore the impacts of other temperature increases, such as 1.5°C (as targeted under the Paris Agreement) or 3°C, this level of ambition was chosen based on the TCFD recommendations for scenario analysis, which list 2°C scenarios as an important starting point. Under the No Policy Action scenario, climate action is consistent with current policy, reflecting minimal climate action.<sup>20</sup> The technology uncertainty scenarios – Renewable Revolution, CCS Storm, and Efficiency Boost – reduce the costs of renewables, CCS and energy efficiency improvements to the lower bound in each technology’s sensitivity range. All six scenarios model climate policy through an implicit global carbon price, which could take place through an emissions trading scheme (ETS), carbon tax or other combinations of policies that induce a cost of carbon – see Section 2 for more details. Future technology and policy pathways will lie somewhere between individual scenarios, but these scenarios allow investors to explore the likely extremes of 2°C pathways.

**2. Macroeconomic and energy system variables are then estimated based on an integrated assessment model for each of the six scenarios.** The set of variables includes energy service demand, global oil and gas, and coal consumption, renewable and EV deployment. TIAM also estimates the effective carbon price<sup>21</sup> (implicit and explicit), based on the cost of abatement<sup>22</sup> and the need to curb emissions. This price represents the cost shock in the cost and competition model described below.

**1. Three bottom-up value stream models are then used 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 climate action might impact investor outcomes:

**a. Cost and competition model:** 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. These mechanisms are modelled using a microeconomic model of sectoral competition, and financial (Thomson Reuters Datastream), and emissions data (Trucost). This model is applied on a sectoral basis, covering over 130 individual markets;

**b. Demand destruction model:** fossil-fuel producers also face a reduction in demand due to the emissions associated with consuming fossil fuels. This mechanism is modelled through economic analysis of each market, and oil and gas industry data (Rystad Energy). Demand destruction also affects coal producers, and conventional automobile manufacturers;

**c. Cleantech market model:** 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 due to the high degree of uncertainty associated with estimates of future market share of new entrants and lack of relevant data.

**4. Finally, equity impacts are estimated as the difference between net present value scenario profits and a ‘No Policy Action’ scenario.** Changes in profit are modelled over the period 2018-50, discounted using a standard equity discount rate of 7.5%, and summed to find the net present value (NPV). The analysis does not try to assess the level of climate action markets have already ‘priced in’ to market caps. Instead, we compared the NPV of losses or gains (under a low-carbon versus ‘No Policy Action’ scenario) to the current market cap of each company. The analysis covers all markets to which MSCI ACWI equities are exposed, based on the Thomson Reuters Business Classification (TRBC) system. Current market valuation is taken to be the market capitalisation of each equity at July 2018.

**This illustrative set of scenarios can be expanded to explore factors such as the stringency of climate targets, other sources of variation in emissions abatement costs and regional as well as sectoral coverage of emissions reduction policies.**

<sup>19</sup> Throughout this report, a 2°C-aligned climate action scenario is one in which climate policy has at least a 50% chance of limiting warming to 2°C. This is similar to the IEA Sustainable Development Scenario (SDS), as well as its earlier WEO 450 scenario. In comparison to the IPCC 1.5° Special Report (2018), the scenarios used here are in between IPCC scenarios for achieving 1.5° C with a 50-66% probability, and scenarios for achieving 2° C with a 50-66% a probability.

<sup>20</sup> Warming levels under the No Policy Action scenario are high, at around 3.3 – 3.8°C, reflecting limited policy action to date.

<sup>21</sup> Reductions in CO<sub>2</sub> emissions from non-energy sources and other greenhouse gases are modelled separately and are netted from the 2°C carbon budget available to energy sectors modelled in TIAM.

<sup>22</sup> The technology cost data used in the TIAM scenario runs comes from a wide range of sources, including the IEA’s ETSAP technology briefings and more additional, in-depth expert analysis of key technologies.

## 4. Equity-level impacts

Three main mechanisms are modelled to evaluate equity-level impacts: direct carbon costs imposed upon emitters, lower fossil-fuel demand and higher cleantech demand

### 4.1 Carbon costs facing emitters

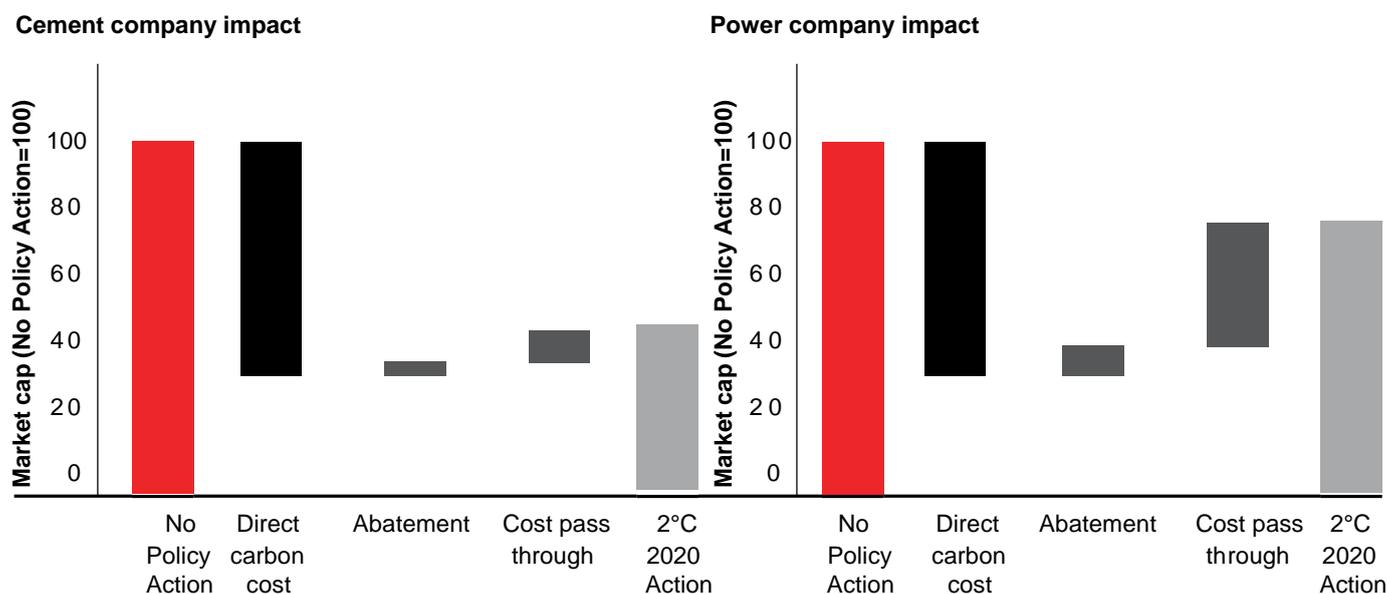
**Under all the illustrative scenarios, heavy-emitting sectors will face higher costs due to climate policy, but profit impacts will vary depending on relative emissions intensity, abatement potential and the ability to pass through costs to consumers.** Across all scenarios, heavy-emitting sectors will face an increased cost of emissions as they will have to either pay carbon costs based on emissions or implement costly abatement opportunities. The impact on firm profits will depend on two key factors: future emissions intensity, which depends on current emissions intensity and abatement potential; and the ability to pass costs to consumers. This report's analysis of carbon costs covers all sectors in the MSCI ACWI, however, the greatest impacts are for activities such as power generation, cement, iron & steel, aluminum, and fossil fuel extraction that are energy-intensive or that produce high process-related emissions.

**Although there is only limited experience with stringent climate action to date, the results of the analysis appear broadly well-aligned with that experience.** For example, power companies with a high-carbon asset base face declines in market valuation of c.65% in the 2°C 2020 scenario. This matches well with the experience in Germany from 2000-2015.

**Companies with the same emissions intensity may face very different profit impacts depending on firm and sector characteristics.** Carbon footprint measures attribute the same climate risk exposure to companies with equal emissions intensity. While such companies will face the same direct carbon-cost burden, climate exposure may differ considerably due to differences in relative emissions intensity, abatement opportunities and cost pass-through rates.

**Figure 3 shows impact channels for a power and a cement company with the same emissions intensity – the power generator could be considerably better off than the cement producer.** In this example, the two companies face identical direct carbon costs, but more of the power generator's emissions are cost-effectively abated compared to the cement company. The power generator also has a higher cost pass-through rate than the cement company. This reflects features of the two markets, such as low price sensitivity of demand and no product differentiation for electricity, as well as the emissions intensity of each company relative to its competitors. The power sector faces lower price elasticity than the cement sector. Moreover, the cement producer in this example has high emissions intensity relative to its rivals in the cement industry, whereas the power generator has a lower relative emissions intensity. As a result, the power generator can pass through more of its carbon cost burden without raising prices significantly above its rivals, while the cement company can pass through little of its cost increase. Overall, value impairment is significantly higher for the cement producer than for the power generator.

**Figure 3: Companies with equal emissions intensity in different sectors may have very contrasting returns**



Note: Results are based on the 2°C Early Action scenario and data from Thomson Reuters and Trucost.

Source: Vivid Economics/HSBC Global Asset Management.

**Some companies within high-emitting sectors may even benefit from a low-carbon transition, due to rising prices and low emissions intensity relative to their competitors.**

The best performing company in the European power sector could gain 82% in value in a 2°C 2020 Action scenario relative to the No Policy Action scenario. Rising carbon prices affect the rest of the industry more adversely than these companies, with prices rising according to the industry-average cost increase and cost pass-through rate. Companies with low relative emissions intensity may reap windfall profits through having industry-average rises in price, but below-average increases in cost. These firms may also gain market share from their emissions-intensive rivals. The relationship between emissions intensity and future profitability is not straightforward, and analysis which omits these factors may produce misleading results.

**Variation in carbon-cost impacts across scenarios depends critically on the timing and stringency of policy.**

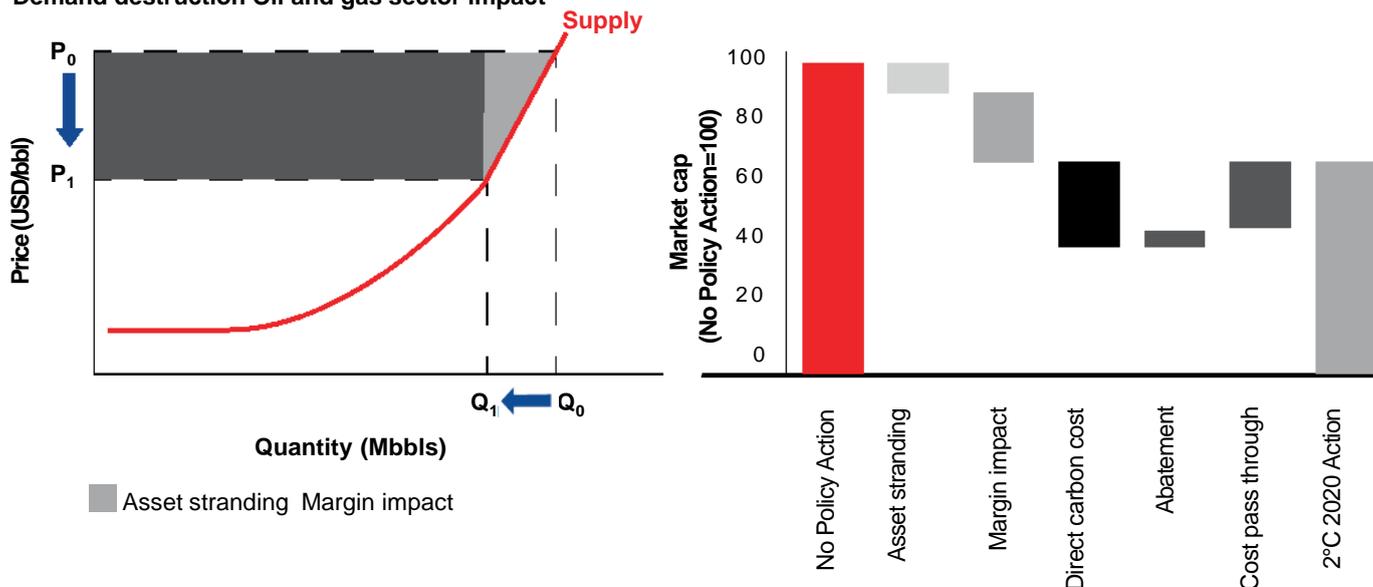
In the three technology cost scenarios, one abatement technology is made cheaper, driving down carbon prices relative to the technology-neutral 2020 Action scenario. This leads to reduced carbon-cost exposure for emitters. However, the carbon price level is not the only factor driving impacts. While 2030 Action results in much higher carbon price levels than 2020 Action, these prices apply much later. This difference in timing means that the higher carbon costs have a reduced impact on valuations today.

## 4.2 Demand destruction in fossil-fuel sectors

Based on our analysis, fossil-fuel sectors are highly exposed to the low-carbon transition, although the analysis suggests most profit losses arise from squeezed margins rather than stranded assets.<sup>23</sup> In all climate action scenarios, overall oil and gas sector profits fall due to lower demand for fossil fuels. Profits fall via two channels: a margin effect and an asset-stranding effect. The left panel of Figure 4 shows the effect of quantity contraction on the oil market – prices fall, leading to lower margins for all fields which are still economical, while the most expensive fields become unprofitable, that is, stranded. In the 2°C 2020 scenario, the margin effect is found to be larger, with oil and gas companies experiencing 22% profit losses due to falling margins and 10% due to asset stranding, as shown in the right panel of Figure 4.

**Figure 4: Fossil fuel producers are impacted by asset stranding but margin impacts are more significant**

Demand destruction Oil and gas sector impact



Note: Results are based on the 2°C 2020 Action scenario and company-level data from Thomson Reuters, Rystad Energy, and Trucost. Mbbbls are millions of barrels; the oil and gas sector consists of all MSCI ACWI companies reported as part of the 'Oil and Gas Producers' sector, which are also actively engaged in upstream oil and gas activity.

Source: Vivid Economics/HSBC Global Asset Management.

<sup>23</sup> Fossil fuel demand destruction analysis considers the impact of climate policy action on the economic value of reserves extracted by each company under the No Policy Action global consumption path to 2050. This covers fields currently being extracted, and those which are currently under development. Asset stranding is here defined as the share of No Policy Action scenario profit lost due to the reduction in quantity extracted. In other words, the "asset" stranded is the fossil fuel left unextracted, and the value impact of that stranding is the reduction in profits that were expected from that unextracted asset. This contrasts with other metrics of asset stranding, such as the proportion of reserves which remain unextracted under climate policy scenarios, or the value of capital prematurely retired.

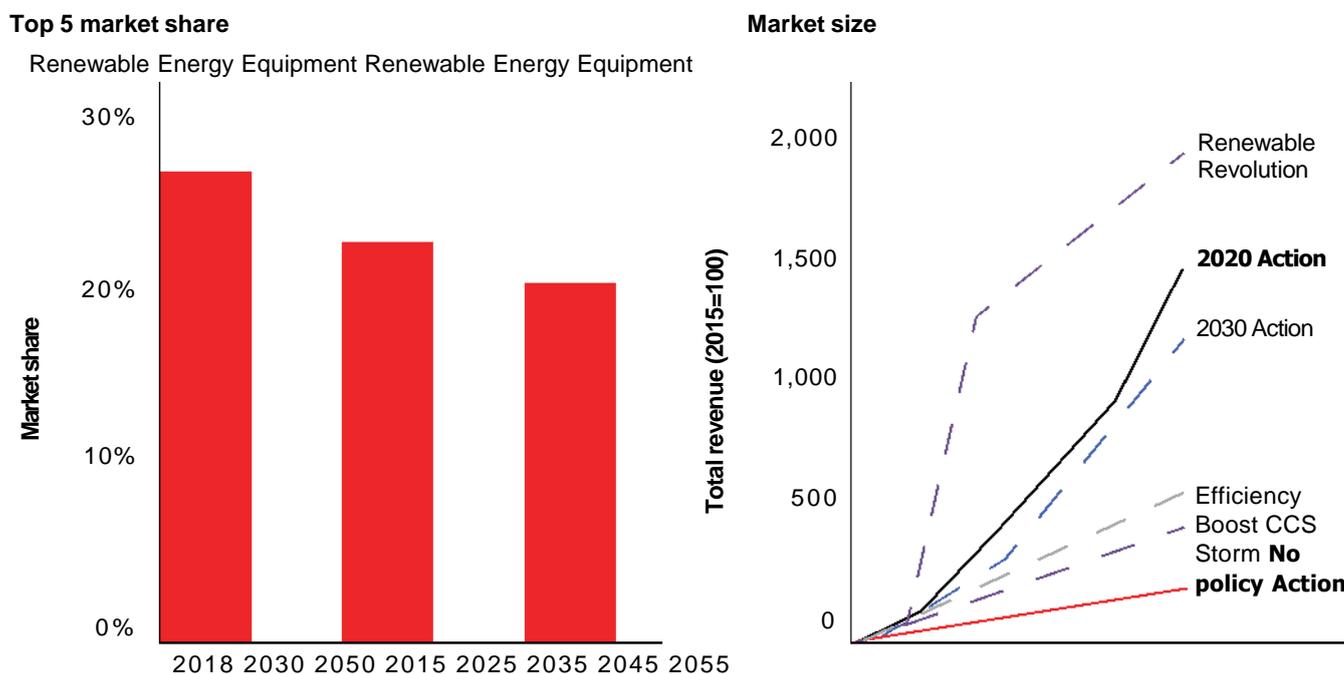
**However, individual extractive companies may outperform their peers due to relatively cheap production, short production horizons, and a high share of natural gas.** The 10 best performing oil and gas companies could gain c.30% in the 2°C 2020 Action scenario relative to No Policy Action. Many of these companies have large gas portfolios, benefiting from higher global demand for gas in the short- to medium-term in the illustrative scenarios. The best-performing companies also have relatively low production costs, experiencing fewer stranded assets and smaller percentage falls in their profit margins. In contrast, the ten worst performing producers could lose c.70% in the 2°C 2020 Action scenario, reflecting high production costs, and low shares of gas production. The timing of production also affects exposure – fossil-fuel producers extracting from short-term assets perform better, due to lower exposure to future demand shifts and price decreases.

**Oil and gas company valuations across scenarios will vary based on technology costs and policy timing.** The Renewable Revolution scenario significantly reduces demand for fossil fuels, as renewables offer emitters cheap emissions abatement opportunities. By contrast, in the CCS Storm scenario, gas demand increases sharply in the early years before falling off in later years. High CCS deployment could significantly raise the value of companies with a high share of gas production.

### 4.3 Green opportunities in cleantech

**Based on our analysis, the cleantech equities with the highest growth will be those that are most innovative, in the sectors with immediate, high market growth.** Markets will grow to different sizes across scenarios, with demand depending critically on their relative costs and the level of policy support for various low-carbon technologies. Equities in sectors with immediate and large market growth should benefit from the largest boost in demand. Within-sector variation in company growth is driven by shifts in market share. While companies with high initial shares – measured using FTSE Russell Green Revenue data – should maintain much of their competitive advantage, those with high innovative strength – measured using Orbis Intellectual Property data – will see the most value growth, taking over some of the market share of the big players, as the left panel of Figure 5 illustrates. While the emerging nature of many clean technologies makes future market entry likely, currently available data is insufficient to assess how much market share these entrants may hold in the future. As a result, the analysis is limited to those companies already present in each cleantech market.

**Figure 5: Market share of the top 5 renewable energy equipment manufacturers drops in the 2°C 2020 Action scenario, but the overall market grows considerably across all 2°C scenarios**



Note: Results are based on the 2°C 2020 Action scenario and data from Orbis Intellectual Property and FTSE Russell Green Revenue. Renewable energy equipment is the sector defined as such under the Thomson Reuters Business Classification (TRBC).

Source: Vivid Economics/HSBC Global Asset Management.

**The rapid uptake of renewables in recent years highlights the financial opportunities arising from a low-carbon transition.** Wind and solar power generation tripled between 2010 and 2015, due to a combination of technology cost reductions and a favourable policy environment. The scenarios shown in Figure 5 explore this trend, with the 2°C 2020 Action scenario resulting in deployment of renewable energy equipment tripling between 2020 and 2030. Most publicly-available low-carbon scenarios also predict renewable sources playing an increasingly important role in future energy supply.

**Once again, although to date there is only limited experience with stringent climate action, the results of the analysis appear broadly well-aligned with that experience.** For example, the best performing EV manufacturers see their value double, compared to Tesla’s market cap increasing by 105% from 2014 to 2018.

**Across the illustrative scenarios, the value of cleantech companies varies according to the deployment of different abatement technologies.** Markets for different green technologies vary significantly in size across scenarios: in the Renewable Revolution scenario, the market for renewables grows to five times the size of the No Policy Action scenario market in 2050, compared with four times the size of the 2020 Action scenario market. This is because we assume that emitters are able to use cheap renewables for emissions abatement in the Renewable Revolution scenario. In contrast, the High Efficiency scenario results in a smaller market for EVs relative to the 2020 Action scenario, as we assume all sectors require less energy and generate fewer emissions in producing the same amount of output, which also means fewer EVs are required to achieve the same emissions reductions as in the 2020 Action scenario. The right side of Figure 5 shows the market size of the renewables sector relative to 2018 across the six illustrative scenarios.

## 5. Investor insights

### Sector-level impacts can be considerable, with significant variation found in company-level impacts

The economic and value stream modelling used in this report calculates the Net Present Value (NPV) of changes in profit over the period 2018-50 for each equity under each low-carbon scenario versus a 'No Policy Action' scenario. While it estimates the impact of three primary mechanisms expected to drive significant shifts in value, it is not comprehensive, and it inevitably relies on a number of assumptions that simplify actual market dynamics. Moreover, the analysis does not try to assess the level of climate action that markets have already 'priced in'. Instead, we simply compare the NPV of the estimated losses or gains (under a low-carbon scenario versus a No Policy Action scenario) to the current market cap of each company. This provides a first estimate of the magnitude of value impact, which investors can use to consider whether they have sufficiently accounted for the potential impact of climate action, and whether it is fully priced into current market valuations. Due to the limitations in the precision of the analysis and uncertainty around what the market is currently pricing, the absolute numbers should be treated as purely indicative. Nevertheless, by looking at the relative size of impacts across sectors and companies, and at the variation of impacts across scenarios, investors can derive useful preliminary insights about the nature and scale of climate action risks and opportunities, and their potential implications for investment strategies.

#### Summarising equity-level impacts derived from the model across illustrative scenarios results in five primary insights for investors to consider.

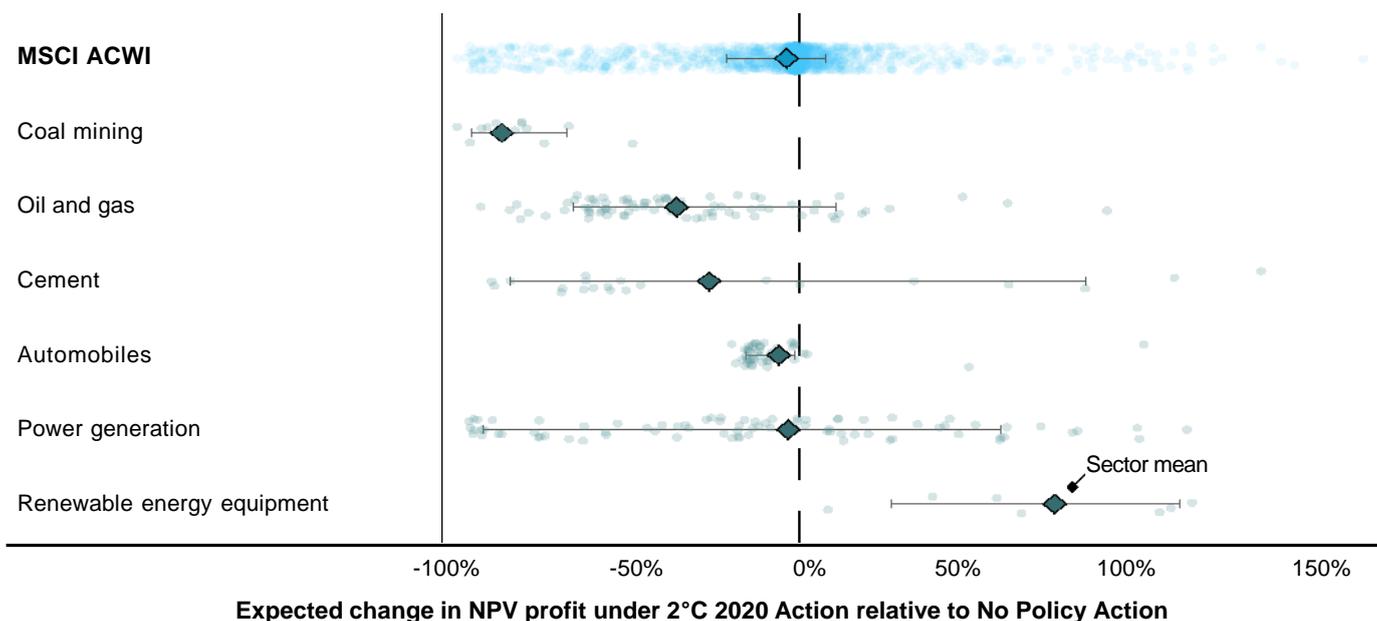
**1. Aggregate impacts on the MSCI ACWI are limited across the transition scenarios analysed.**<sup>24</sup> Results from the 2°C 2020 and 2030 Action scenarios suggest that value impairment at the MSCI ACWI level will be limited to around a 2% fall in total market cap. Diversified equity portfolios contain a wide range of stocks which are affected differently by climate transition policy. Sectors such as technology, finance, communications and healthcare are largely unaffected by the climate transition using the modelling approach outlined. By contrast, emissions-intensive sectors, such as cement, are adversely and significantly impacted, while cleantech sectors such as renewable energy equipment and EVs are better off. This analysis expects these offsetting effects to lead to limited aggregate impact at the portfolio level.

**2. However, there are significant differences in exposure across sectors.** In the scenarios, some sectors experience significant value destruction or gain, others experience only moderate effects. In the 2°C 2030 Action scenario, coal mining companies suffer an average value impairment of 49%, while renewables gain 37%. By comparison, in the 2°C 2020 Action scenario, coal companies lose 81%, while renewables gain 72%. The average value impairment for emissions-intensive industrial sectors such as cement under the 2°C 2030 Action scenario is more moderate at 13%. Figure 6 illustrates these modelled impacts in comparison with aggregate portfolio-level impacts for the 2°C 2020 Action scenario, with results for the 2°C 2030 Action scenario shown in Figure 7.

**3. Even within a sector, impacts on individual equity values can vary considerably.** For instance, in the power generation sector, the best-performing 10% of companies are 54% better off in the 2°C 2030 Action scenario compared with No Policy Action, while the worst-performing 10% are 48% worse off. Even the growth of companies within the cleantech sector will not be homogeneous, as each company's performance will depend on growth in demand and changes in market share. As an example, in the 2°C 2030 Action scenario, the value gain for companies producing renewable energy equipment ranges from a 16% to 60% increase in value compared with No Policy Action. The bars in Figure 7 illustrate these impacts in the sectors that have been identified as being most likely to be significantly affected by the transition.

<sup>24</sup> All analysis of value impairment is expressed as a percentage of the current market cap of the MSCI ACWI constituent companies, and makes no assumptions about potential changes to the constituent companies in the future, or about their share in the index.

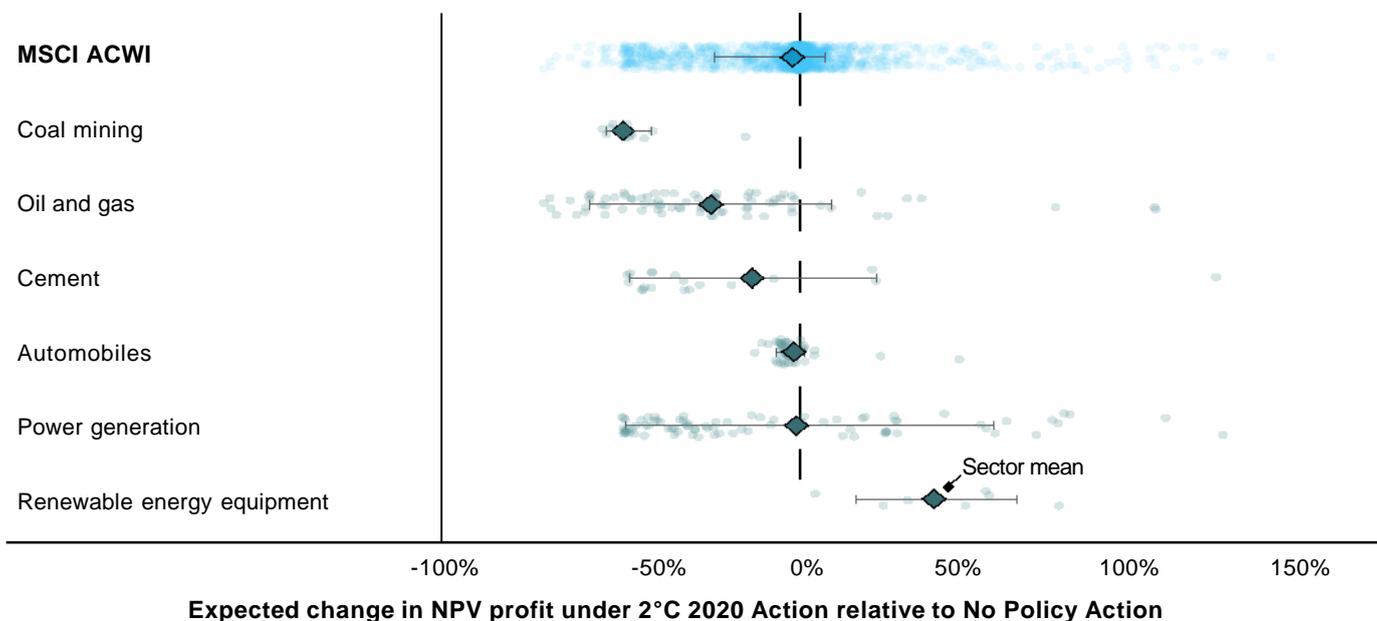
**Figure 6: While portfolio level impairment is small, sector-level impacts can be large in the 2°C 2020 Action scenario**



Note: Bars show the range between the 10th and 90th percentiles of company performance within each sector, and for the MSCI All Countries World Index as a whole; results are based on the 2°C 2020 Action scenario, and data from Thomson Reuters, Trucost, Rystad Energy, Orbis Intellectual Property, and FTSE Russell Green Revenue. These sectors represent a subset of those analysed, which covered all sectors in which there are companies listed on the MSCI ACWI.

Source: Vivid Economics/HSBC Global Asset Management.

**Figure 7: Impacts across and within the most exposed sectors are more modest in the 2°C 2030 Action scenario but there are greater negative impacts on the aggregate economy**



Note: Results are based on the 2°C 2030 Action scenario.

Source: Vivid Economics/HSBC Global Asset Management.

**4. The analysis allows for the identification of common characteristics of relative ‘climate winners’, across our illustrative scenarios, in sectors highly exposed to the transition:**

- ◆ within emissions-intensive industries, those with relatively low emissions intensity, producing goods for which demand is price-insensitive and able to pass costs through to consumers;
- ◆ within fossil-fuel extraction, those with gas-focused portfolios, short production horizons and relatively low production costs; and
- ◆ within cleantech, those in fast-growing markets, with significant market shares and relatively more unrealised IP.

Importantly, these findings also suggest that today’s most common approaches – identifying exposure based on carbon intensity or on sector-level ‘science-based targets’ – may not capture the most important drivers of variation in financial outcomes.

**5. 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.**

- ◆ At the MSCI ACWI level, there is limited variation across scenarios, although value losses are slightly smaller under the 2030 Action scenario due to short-term investment horizons and high equity discount rates. However, this scenario has a greater negative impact on the aggregate economy, as policy needs to be more stringent to make up for lost time.
- ◆ At the sector level, exposure can vary considerably across scenarios, with technology the more important sensitivity for sectors such as oil and gas, and renewables, but timing more important for coal and cement, for example:

- The **oil and gas sector** suffers a value loss across scenarios ranging from circa 25% to 40%, with somewhat better performance in the 2030 Action and CCS Storm scenarios.
- **The coal sector** suffers very large value loss, ranging from circa 50% to 80%, with the smallest losses occurring under a 2030 Action scenario, highlighting the sector’s particular sensitivity to the timing of climate action.
- **The cement sector**, typical of energy and emissions intensive sectors, suffers relatively smaller value losses ranging from circa 10% to 25%, with exposure more affected by timing than by technology pathway under the scenarios.
- In contrast, **automobiles and renewables** are more sensitive to technology pathway than policy timing assumptions. In the extreme case of renewable energy equipment, average value gains across the sector range from circa 10% to 130% across the three technology scenarios.

- ◆ For individual companies, differences across scenarios are similarly pronounced, for example:
  - The 10 **oil and gas companies** with the greatest exposure to gas actually gain 17% in value from growing demand in the CCS Storm scenario, but lose 13% in the Renewable Revolution scenario.
  - For the 10 most emissions-intensive power utilities, value losses are 88% in the 2°C 2020 Action scenario, but fall to only 48% in the 2°C 2030 Action scenario.
  - The most exposed renewable energy equipment companies gain almost 300% in value in the Renewable Revolution scenario, but only 10% in the cheap CCS scenario.

**The range of outcomes across the six illustrative scenarios highlights some of the significant uncertainties related to the pathway of the low-carbon transition. This underlines the importance of scenario analysis in understanding the impact of investing in a transitioning economy and the benefit to considering a range of scenarios covering key dimensions of uncertainty.**

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