CLIMATE CHANGE
GLOBAL
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HSBC Global Research

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Keeping it cool

Assessing climate risk

The global urgency to address climate change...

...makes it more important than ever for investors to assess climate risks

The HSBC Climate Risk Analysis Framework shows how this can be done

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Executive Summary

Climate Risk Assessment: What next?

We expect climate change to be a disruptive factor for the value and income generating potential of assets. The risk factors relate to regulation for reducing and decarbonising energy use as well as how asset values will hold up to natural events such as extreme weather. In addition, legal challenges to corporates for inaccurate or misleading climate disclosure are rising. This report sets out a framework to assess climate risk and provides investor strategies.

Climate analysis warrants focus: The rationale for taking climate into account in investment decision making is on the rise. The preparation for the Paris climate talks and the outcome itself established climate change as a topic on the global diplomatic and economic circuit. China and the US have partnered to ratify the Paris Agreement and China has used its presidency of the G20 to promote green finance. We expect Germany to continue with the green finance theme during its presidency, but also to push for stronger disclosure on climate risk from corporates and financial sector participants. We think investors will increasingly be pushed to demonstrate how their capital management strategies are aligned with supporting the transition to a low-carbon economy, rather than hindering it. The rationale for increased climate analysis is set out in Chapter 1.

Value preservation: The long-term nature and uncertainty around how the consequences of warmer temperatures will play out has historically hampered thinking on integrating climate factors into asset valuation. Based on our estimates however, the carbon budget for a 2°C world, which was the minimum goal agreed at the Paris talks, (i.e. ideally temperature rises will be less than that) runs out in 2040. Limiting temperature rises to 1.5°C means the budget expires by 2023 on current trends. We think it is important to establish expectations around future asset value resilience to the changing norms brought about by climate change – the HSBC Climate Risk Analysis Framework provides the toolkit to do this.

> **“ Establishing expectations around future asset value resilience to the changing norms brought about by climate change is difficult, but critical**

Triple whammy: The risks associated with climate change come from moving to a low-carbon economic framework, adjusting to warmer temperatures and being accountable for action that is detrimental to the climate. These risks are inter-dependent, in the sense that the likelihood of one playing out changes the likelihood of the others. For instance, if the move to a low-carbon world happens quickly, the likelihood of disruption from changing weather norms will be

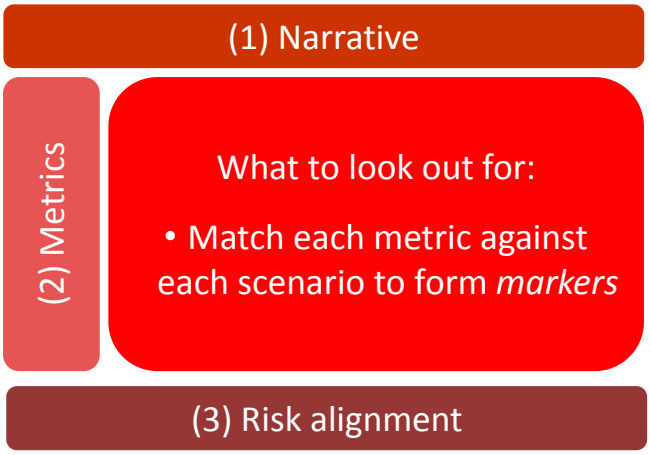
reduced, but the risks related to the transition to a low-carbon world, like lower demand for high carbon goods and services, will be higher. If no changes are made to become more energy efficient and decarbonise energy supply, the risks in relation to transitioning to a low carbon economy are lower, but the risks related to the potential disruption potential later are higher. We look at types of climate risk in Chapter 2 from page 15.

A framework to analyse risk: Ultimately, our aim with this analysis is a framework mechanism that asset managers can use to better-assess the risks related to future asset values, income generation potential and returns in the face of uncertain responses to climate change. Figure 1 provides the big picture backdrop of the approach, which in our view comprises three steps:

- choosing an over-arching narrative with scenarios of how the future might look,
- identifying relevant metrics that provide a basis for monitoring what is happening,
- estimating what the intersection of scenarios and metrics means for climate risk in a portfolio

These three steps can be used at an economy-wide level, for sectors, or for individual stocks. We step through this process in Chapter 3 from page 21.

Figure 1: HSBC Climate Risk Analysis Framework



Source: HSBC

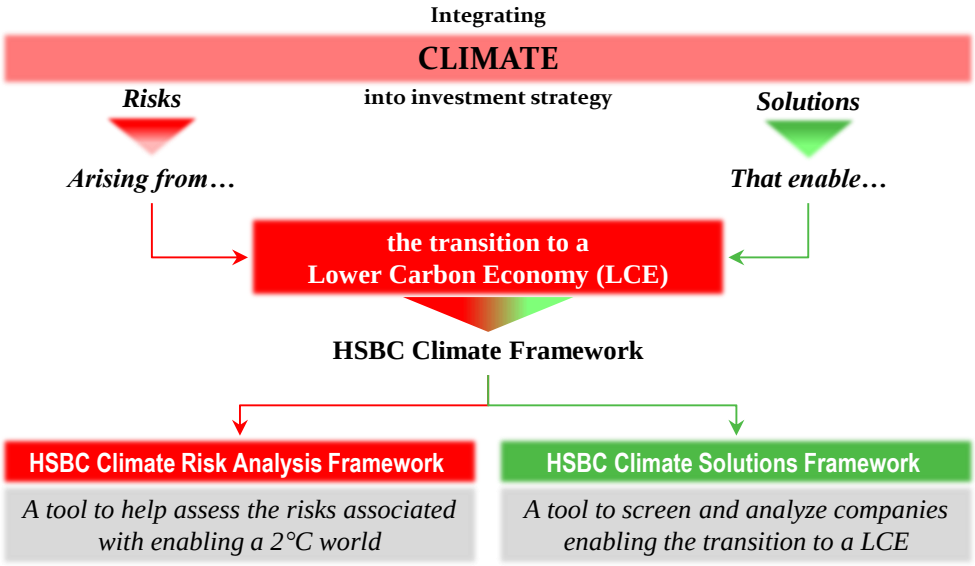
Investor preferences: We think investors can tailor the Climate Risk Analysis Framework for their own circumstances, such as beliefs on how the transition to a low-carbon economy will develop, as well as risk appetite and investment horizon in relation to their own specialist area. For instance, an index tracking fund manager might want to look at high-level, broad scenarios similar to the ones we set out from page 25. Alternatively a utilities analyst will probably want to assess a more specific future around how the demand for high carbon coal in power will evolve in the future. We set out climate risks in a sector context on page 34.

Investor strategies: In Chapter 4, on page 36, we map out an investor strategy for integrating climate change. In the past, climate discussion mainly centred on a high-level commentary of which sectors fit into 'high-carbon' and 'low-carbon' buckets. In addition, carbon foot printing (the measurement of how much CO_2 is emitted by the company in the course of day to day operations) has been used as a tool to assess company willingness to understand and address operational climate factors. While still useful, this type of analysis is no longer enough to identify and endorse a climate based company differentiation in our view. As investors are put under more pressure to demonstrate their own climate credentials, we expect them to be asked to provide increasingly sophisticated rationale to defend portfolio holding decisions, particularly for

energy and industrial sectors. We think a comprehensive climate strategy has three equally important considerations:

- Assessing the climate risk embedded in portfolio holdings (as set out by the HSBC Climate Risk Analysis Framework)
- Identifying climate solution providers (as set out by the HSBC Climate Solutions Framework)
- Differentiating between companies within sectors to assess the likely winners in the transition to a low-carbon economy by adopting a company engagement strategy

Figure 2: HSBC Climate Frameworks



Source: HSBC

In the accompanying report *'HSBC Climate Solutions Framework'*, 12 September 2016 (Please contact your HSBC representative or email Research.Direct@hsbc.com for more information on how to access the full report) we put forward a separate framework for identifying climate solutions. This is a comprehensive methodology that helps to screen and analyse global companies that focus on addressing, combating and developing solutions to mitigate and overcome the effects of climate change. The resulting database from that solutions framework lays out the investment opportunity set in the climate change space.

Investor engagement: Much of this type of climate analysis hasn't been done before, and as such a lot of the information needed to differentiate between companies within a sector is not yet disclosed. We expect regulation and investor coalitions to provide the catalysts for more comprehensive climate reporting. As both climate risks and opportunities become more prevalent, and investors become more demanding, we expect a new phase in integrated climate analysis.

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Contents

The importance of climate analysis

- Investor initiatives to implement the Paris Agreement focus on improving climate risk disclosure to enable AUM decarbonisation
- Climate-related risk relates to *transition*, *physical* and *liability* risks; these impact the ability to income and maintain asset value
- The task is to factor-in these risks as a matter of course and assess investment portfolio resilience in the face of tightening climate goals

Climate goal is to halt Greenhouse Gases (GHGs)

Keeping temperatures down is a global challenge

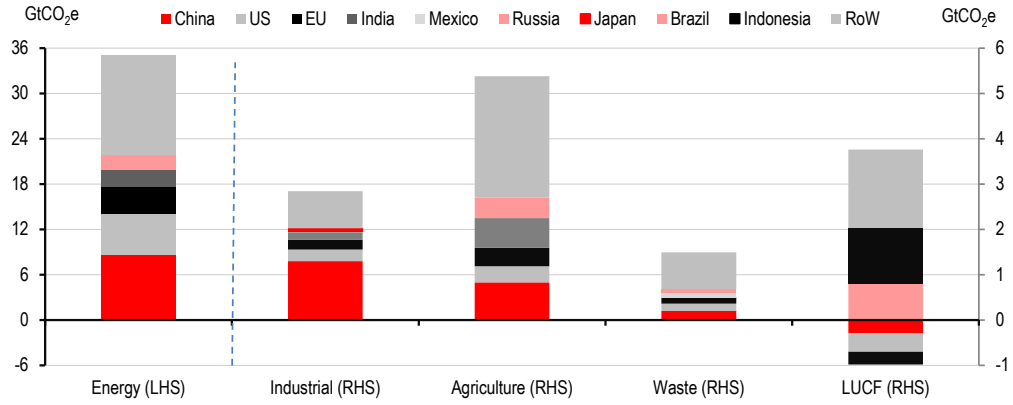
The scale of the challenge of keeping climate change in check is significant. Global GHGs have been rising by 2% on average in the last decade, and, even if all country plans put forward in advance of the Paris talks are implemented, the UN notes that GHGs would rise from Gt47CO_2e in 2012 to Gt55CO_2e by 2030. However, the best estimate put forward in the Paris Agreement text is that an annual GHG level of Gt40 would be more consistent with a 2°C world.

Gt47
Annual global GHGs in 2012

Gt40
Annual global GHG allowance for 2°C

So far 26 parties, covering 39.1% of Greenhouse Gases have ratified the Paris Agreement, including the US and China. We think this provides a further signal that policy implementation and capital allocation will move towards a low-carbon framework, which will change the economics of high carbon versus low carbon goods and services. A focal point of the Agreement is the mitigation section (Article 4), which aims to “reach global peaking of greenhouse gas emissions as soon as possible”. The Paris aim means halting and reversing the GHGs that come from energy, industry, agriculture, waste and land use change and forestry (Chart 1).

Chart 1: Sources of GHG emissions by sector, broken down by country



Source: World Resources Institute, CAIT Database, LUCF is land use change and forestry where a negative value denotes GHGs are taken out of the atmosphere

Individual country climate plans and pledges are freely available for anyone to view

The country plans that were put forward ahead of the Paris climate talks are publicly available for anyone to scrutinise. However, the synthesis report that added up all the plans revealed that the full implementation of climate pledges from the 189 parties submitting a plan still results in an emission gap between what is consistent with a 2°C world and business as usual. Essentially, the plans only narrowed this gap by 18%. This points towards the necessity of upward ambition of action as and when the impacts of climate change such as the linkages of extreme weather and warmer temperatures become clearer.

> **Solving climate change means halting and reversing the GHGs that come from energy, industry, agriculture, waste and land-use change**

Besides emitting less, in the future, we also need to be able to absorb more GHGs

Looking further out, the aim is to get to a world of net zero emissions (see Box 1). The rationale here is that the peak warming of the climate system is driven by cumulative emissions of long lived greenhouse gases as well as future emissions. This means that ultimately, to prevent temperatures rising for hundreds of years, at some point carbon sinks must equate to carbon sources to balance the earth system.

Box 1: Net zero emissions: describes the situation where there is a balance between the sources (emissions) and removals (sinks or capture) of anthropogenic GHG emissions. Article 4 of the Paris Agreement aims to achieve this "in the second half of this century". In the future we expect net zero thinking to become much more prevalent, as science and measurement metrics become more developed.

BOX 2: Measuring progress towards a 2°C world

Without waiting to take the temperature of the earth in the future, there are a number of ways to estimate whether progress towards the 2°C limit is on track. It may be described in terms of:

Atmospheric concentration: Initially, climate scientists used atmospheric concentrations of CO_2 as a threshold for a 2°C world. i.e. for a 50% chance of limiting temperature rises to 2°C, molecules of CO_2 should be no more than 450 parts per million parts (ppm) of atmospheric molecules. *Concentrations* of CO_2 can be directly monitored in realtime, in contrast to global *emissions* which are estimated and published annually. Hence CO_2 ppm is a useful indicator of future warming trends. The readings from the Mauna Loa observatory in Hawaii are the most commonly cited. However, this method does not take into account other greenhouse gases which have a higher global warming potential such as methane.

Carbon budget: indicates the amount of carbon that can be emitted into the atmosphere cumulatively, for a given chance of limiting warming to 2°C. i.e. the more that is emitted, the less chance of keeping within 2°C. Note, this is based on *carbon* and not *carbon dioxide* (although it can be converted to CO_2 easily). In its Fifth Assessment Report (AR5) published from 2013, the Intergovernmental Panel on Climate Change (IPCC) set a one trillion tonne (1,000GtC) cumulative budget for the amount of *carbon* (and equivalent in GHG terms) that the global economy can emit for a 66% chance of staying under 2°C.

This 1,000GtC is the budget before accounting for warming from other GHGs such as methane, nitrous oxide and F-gases (i.e. *non-CO_2 forcings*), which effectively reduce the budget even further.

Converting this to *carbon dioxide*, after taking into account *non-CO_2 forcings* and historical emissions to 2011, the future budget (2012 onwards) for a 66% chance of limiting warming to 2°C, is around 1,000GtCO_2. For a 50% chance, this budget increases to 1,300GtCO_2; and for a 33% chance, it is 1,500GtCO_2 i.e. we can emit more but that comes with more risk.

Estimation of the year of budget expiry depends on the trajectory of future carbon emissions. We have used 7 different trajectories, which range from a simple growth rate extrapolation to a judgement on when global GHGs will peak in the future. The years below reflect the average mid-year of these trajectories.

Table 1: The carbon budget based on various chances of limiting warming

	For the chance of limiting warming		
(in GtC, gigatonnes of carbon)	**>66%**	**>50%**	**>33%**
2°C			
Budget from 2011 onwards	1,000	1,300	1,500
Budget runs out around	2040	2050	2060
1.5°C			
Budget from 2011 onwards	400	550	850
Budget runs out around	2023	2027	2035

Source: Final Synthesis Report (AR5) – IPCC, HSBC calculations on expiry year based on average of various pathways

We think the carbon budget approach is a good method because it is easy to understand (don't overspend), it measures GHG emissions directly (annual and cumulative emissions), and covers all GHGs.

Drivers for integrated climate assessment

Climate negotiations are a form of global diplomacy

Political emphasis

Climate change is now as well established a topic on the global political arena as the economic backdrop, national security and population migration in our view. Many G7, G20, World Bank, IMF and bilateral Heads of State meetings are flanked with a statement on climate. This volume of political emphasis makes it hard to envisage a complete U-turn stance on climate positioning in our view. For instance, we think the overwhelming support from Heads of State at the opening ceremony of the climate talks in December 2015 was a key factor for the delivery of the agreement.

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World leaders at the Paris climate talks

Most major international talks such as G20 or Davos now include climate change

Global diplomacy

Although we expect the volume of national public statements with climate emphasis to ebb and flow in relation to other political and economic factors, we expect ongoing 'hidden' bilateral diplomacy on climate across countries, such as in the way that China has actively worked bilaterally with the US since 2013, or China's championing of the green finance agenda during its G20 presidency in 2016. We expect Germany, which holds the G20 presidency in 2017, to work towards incorporating climate change into financial stability.

The IPCC will publish a report in 2018 about the impacts of 1.5°C of warming

Science

Several factors have driven diplomacy on climate, including twenty years of collaboration under the UN Framework Convention on Climate Change (UNFCCC). A key part of this has been the work from the Intergovernmental Panel on Climate Change assessment reports on Science, Mitigation and Adaptation. The next, and sixth assessment report, is due to be published in parts from 2020/2021, with a final synthesis report in 2022. In September 2018 however, the IPCC will provide a special report on the impacts of global warming of 1.5°C above pre-industrial levels, the related global GHG emission pathways, as well as the political and technological feasibility of the 1.5°C target.

Climate is creeping into most major decisions globally

Integration initiatives

We expect climate factors to become more integrated into financial decision making than they have been previously because of widespread integration initiatives. Previously, even with investor acceptance of the science, there was generally a lack of belief that the impacts would be felt within reasonable timeframes for their decision making on generating returns. In addition, other issues more pressing to deal with in relation to preserving asset values, during times such as financial crisis, economic slowdown, and geopolitical turmoil meant that climate considerations were, in many cases, relegated.

Financial Stability Board Involvement

Financial stability is a bigger focus after the recent global financial crisis….

At the Paris talks, the Financial Stability Board (FSB) announced it was establishing a task force to look at the climate-related financial disclosures necessary to make more informed decisions on the climate risks associated with different industries. The goal of the task force is to develop recommendations on climate-related financial disclosures. These recommendations are due to be submitted to the FSB by the end of December 2016. They are voluntary, but we expect the FSB central bank members to adopt the proposals nationally. The idea is that investors need more information on climate factors related to different assets in order to make more considered

risk return calculations. The preliminary report in March 2016 presented fundamental principles for effective disclosures, which will underpin the future recommendations. These are:

….we think a focus on climate is next as the FSB has begun taking it into consideration

- Present relevant information
- Be specific and complete
- Be clear, balanced, and understandable
- Be consistent over time
- Be comparable among companies within a sector, industry or portfolio
- Be reliable, verifiable and objective,
- Be provided on a timely basis

In the second phase of work, the task force is focusing on four areas: governance, strategy, risk management and metrics. The point of the FSB is to mainstream climate risk assessment across all boardrooms, not just those that report carbon data to CDP.

> **Policy makers have an interest in ensuring that the financial system is resilient to all forms of risk**
>
> **Financial Stability Board**

A smooth transition to a low-carbon work can help to ensure global stability

The rationale of central banks is that since the economy is globally interconnected, it is in the best interests of investors, policy makers, corporates and civil society to enable a smooth transition to a low-carbon world – because the impacts of warmer temperatures will have global consequences. Fossil fuel exposed companies, primarily oil and gas (including mining and services providers), reflect 6%, or around USD2.3 trillion on the MSCI World index (as of 8 June 2016). This is significant in itself but is even bigger when state-owned energy facilities and their supply chains are added, as well as the income they provide for public spending. A shock to these industries, such as a dramatic fall in demand or a more expensive operating environment, could have widespread ramifications for financial markets, as well as the broader economy through employment and tax revenues. We explore these concepts in the following chapters.

Climate disclosure targeted

Stock exchanges require more climate disclosure; accounting standards are evolving to include climate

Globally, many stock exchanges have implemented rules to incorporate environmental, social and governance issues into listing requirements. In addition, accounting standards boards are also working more closely on these issues. For instance, in the EU, a directive issued in 2014 states that the financial statements and management reports of listed companies should include "an analysis of environmental and social aspects of the business necessary for an understanding of the undertaking's development, performance or position." This includes a description of the policies pursued, due diligence processes implemented and the outcome of those policies. Voluntary initiatives have also increased in prominence and momentum. For instance, the sustainable stock exchanges initiative, launched in 2009 aims to promote ESG disclosure and performance among listed companies. We expect national regulation to have cross border impact, because of the global interconnectedness of business and economies.

Countries are addressing resilience

Many countries are assessing resilience to climate change more comprehensively

Countries are looking at adaptation, which means they accept that change is happening and they are concerned with the consequences to their livelihoods and economic development. In preparation for the climate talks which led to the Paris Agreement, more than 130 countries included adaptation planning as part of their intended nationally determined contributions (climate pledges). The IPCC assessment reports highlight that in many cases the countries that are most vulnerable to climate change have the lowest financial resources to deal with them, but as we point out in some of our previous publications, G20 countries are also susceptible to climate risk factors. Among the G20, China, Indonesia and India are the most vulnerable.

Mainstreaming adaptation thinking into country climate planning represents a shift in the global climate mind-set in our view. In previous years, climate negotiators were reluctant to talk about adaptation, because acknowledging the consequences of warmer temperatures meant failing to solve the climate problem, even though the solution was clear to them. Now, a resignation that warming is happening means that adaptation has moved up the national and global agenda and is routinely discussed at all climate talks.

Shareholders are becoming more vocal

A subset of shareholders is becoming more active – and voicing out climate opinions

Shareholder activism on climate has increased, but is at a relatively early stage. More investors are requesting more climate-related information, by asking fossil related companies to look at the climate risks to their operations. Recent high profile shareholder resolutions were put forward at Shell, Chevron and ExxonMobil. For ExxonMobil, shareholders passed Item 7: a proxy access bylaw, which allows minority shareholders with a 3% stake to be able to *nominate* directors to the board – it opens up the possibility of a climate or environmental expert to be put on the board.

Table 2 shows some of the subtle shifts in the thinking of shareholders at major oil and gas companies over the past few years and a marked difference between European and North American oil companies. However, they stop short of making substantial changes to the company's core operating strategy and business model.

Shareholders are using their rights to extract information on climate and cause change

In the US, although investors have mostly rejected all climate-related resolutions in recent years, shareholder awareness of climate-related issues is growing. For example, Proxy Monitor, which tracks shareholder proposals at the largest 250 public companies in the US as ranked by *Fortune*, found that:

- *Over the 2006-16 period,* environment-related proposals comprised 19% of all proposals. Of these environmental proposals, 29% were related to climate change.
- *In 2016 (following the Paris Agreement)*, climate-related proposals rose to 40% of all environmental-related proposals.
- *In 2016*, the 23 climate-related proposals received support from 26% of shareholders, up from 16% in 2015 (and 14% for the 2006-16 period).

We think many asset managers are actively engaging with energy and industrial companies on climate issues on a one on one basis, but we expect the level of public AGM questioning on climate to increase going forward.

Table 2: Climate change is appearing more frequently on shareholder resolutions

Company / Summary of resolution or item	Years		
	2014	2015	2016
BP			
To provide further information on the low carbon transition.		F: by 98.30%	
Chevron			
Regarding an independent director with environmental expertise	A: by 78.6%	A: by 80.1%	A: by 81.2%
Report on shale energy operations	A: by 73.4%	A: by 73.2%	A: by 69.3%
Greenhouse gas emissions		A: by 91.8%	A: by 92.1%
Dividend policy (with relation to capital distribution in the face of stranded assets due to climate change)		A: by 96.8%	A: by 96.5%
Report on climate change impact assessment			A: by 59.2%
Report on reserve replacements			A: by 93.2%
ExxonMobil			
Greenhouse Gas Emissions Goals	A: by 78.0%	A: by 90.4%	
Report on Hydraulic Fracturing		A: by 75.1%	A: by 75.5%
Climate Expert on Board		A: by 79.0%	A: by 79.1%
Policy to Limit Global Warming to 2°C			A: by 81.5%
Report on Impacts of Climate Change Policies			A: by 61.9%
Report Reserve Replacements in BTUs			A: by 94.4%
Shell			
Additional disclosures in relation to risks associated with climate change		F: by 98.91%	
For Shell to become a renewable energy company			A: by 97.22%
Statoil			
Withdraw from oil sands extraction in Canada	A: by 99.51%		
Statoil should not operate in ice-laden waters in the Arctic	A: by 99.87%		
Terminate engagements in Angola and Azerbaijan and reinvest in R&D and production of sustainable energy	A: by 99.87%		
Annual reporting to include operational emissions management, asset portfolio resilience etc.		F: by 99.95%	
Projects within Statoil's portfolio to be assessed for resilience against IPCC AR5 scenarios		A: by 99.07%	
Develop a new strategy for a more sustainable development and administration of the company's resources and business.		A: by 99.76%	
Withdraw the company from polluting and unprofitable ventures, Terminate exploration for new oil and gas sources,			A: by 99.79%

Source: Results of proxy voting for 2016, 2015, 2014 AGMs of BP, Shell, Chevron, ExxonMobil, Statoil as per company website. Note: A = Against; F = For

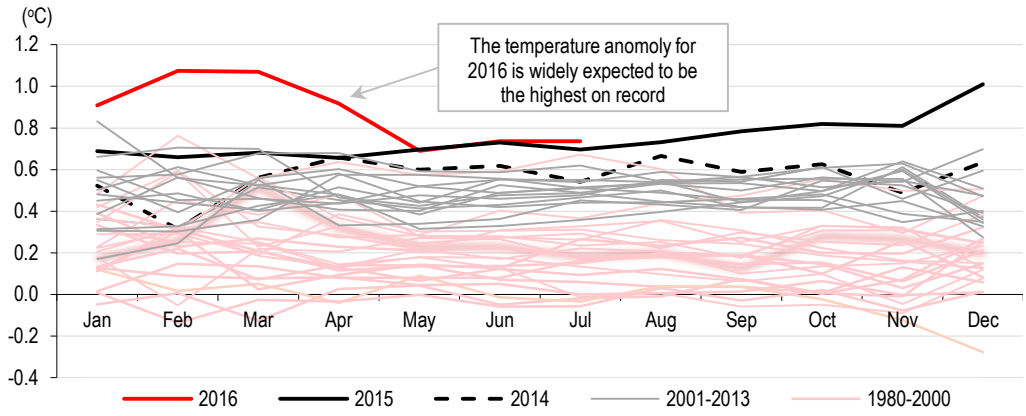
Climate action is coming from a broader base

Many non-state actors (sub-national jurisdictions such as states, provinces, cities as well as companies and investors) are becoming more involved and more vocal on climate change, as evidenced by the UN's NAZCA portal (Non-State Actor Zone for Climate Action) which now has well over 11,615 commitments including 2,531 from cities and regions, 2,090 from corporates and almost 450 from investors.

Civil society is ramping up its efforts, and adding to the pressure, to reduce as well as prepare for climate change

However, many NSAs have not yet begun to address the issue. As a result, **civil society** continues to apply pressure on *all actors* to do more on climate change because the evidence is becoming more apparent. For example, there have been record-breaking temperatures for many months so far this year, with July 2016 being the hottest month ever according to NASA. Leading weather and climate monitoring agencies, such as the UK Met Office, NASA and WMO usually measure temperature changes against a baseline average, such as the thirty year average level from 1961 to 1990. This allows for 'temperature anomaly' reporting. Chart 2 shows the monthly temperature anomaly readings since 1980.

Chart 2: More CO2 traps more heat, which leads to higher temperature anomalies



Source: UK Met Office (HadCRUT4 time series). Note: Average global surface temperature anomaly is relative to the average for the 1961-1990 period.

Reputational risk for investment managers is becoming greater with regards to climate

In advance of Paris many investors participated in collective pledges that showed support for a positive outcome for the agreement, which included aims to decarbonise investments and to address climate change factors. We expect the reputational risk for investment managers that have not implemented these pledges to become more significant in the future. All of these drivers point towards greater disclosure and transparency, which allow investors to estimate the risk reward profile of high carbon assets more accurately.

Regulatory catalysts are in focus

The bar on assessment of climate change in financial markets is being raised – both voluntarily and through regulation (e.g. France)

The outcome of the Paris climate talks has raised the bar on how the finance community addresses climate change in our view. Not only did French diplomacy ensure the climate talks stayed on track, French regulation, by way of the Energy Transition Law (see Box 3), is also pushing French corporates and investors into greater climate disclosure and analysis. We expect these initiatives to have global ramifications, since French asset owners award investment mandates to overseas organisations, and buy shares in overseas companies. In addition, more widespread drivers, such as financial stability, global diplomacy, asset owner initiatives and civil society pressure are pushing for more integration of climate thinking into financial decision making. It's in everyone's (investors, policy makers, corporates, and civil society) best interests if the transition to a low-carbon economy is delivered as quickly and as smoothly as possible and we expect more climate risk assessment to promote an increased demand for disclosure and transparency going forward.

> **We expect disclosure and transparency on both strategic decision making and capital flows to become much more important in a post-Paris world**

We expect the response of the public sector, companies, investors and civil society to the Paris Agreement to drive the speed and scale of implementation, with each developing a strategic response to climate change. Post Paris, we think that the first step for asset owners, investment managers, insurers and banks is to assess the degree to which climate change is a disrupter on the value and income generation potential of financial assets, loans and investments. This is clearly easier said than done since thinking on the relevant disclosure and metrics to marry climate and financial decision making is relatively immature.

Box 3: France's Energy Transition Law

In France, a new law on Energy Transition and Green Growth (Loi de transition énergétique pour la croissance verte) came into force on 1 January 2016. Article 173 of this law covers investors, corporates, and banks. It requires institutional investment firms of a certain size to disclose on an annual basis information relating to environmental, social and governance factors. For climate, it requires the following information to be considered:

1. the exposure to climate risks;
2. a measurement of the GHG emissions associated with assets held;
3. demonstration of the contribution towards international climate targets and the objectives of the Energy Transition Law.

Article 173 also amends the 'French Commercial Code', so that listed companies must report annually on how their activities and the use of their goods and services affect climate change; the financial risks related to climate change; and how the company implements a low-carbon strategy to mitigate these risks.

The law (and the related supporting guidance) do not specify detailed informational requirements but has left French investors much flexibility in how they comply with it. For example, 'exposure to climate risks' is not defined but is open to interpretation. In our view, the increased disclosure from companies provides investors with much more climate-related information with which to base investment decisions (as well as make their own disclosures).

The new provisions are applicable for reports which cover the year ending 31 December 2016, and so should be disclosed to the public from 2017 onwards. We think that the information disclosed may take a few years to tighten up and become more comparable, but over time, we anticipate other jurisdictions following a similar path of disclosure requirements.

Managing asset value resilience

Assessing the resilience of asset value, despite so much uncertainty, is a necessity in finance and investment

The Paris Agreement was pivotal in delivering a global consensus that climate change is a reality. In our view, this means that failing to have a strategy in relation to climate change is no longer an option for governments, corporates and investors. For asset owners, the core focus is to safeguard asset values and provide a future income stream for pensioners. These are naturally long-term liabilities which need to be resilient in the face of long-term climate factors. The fiduciary duty of asset owners means they should sense-check how the future might play out, and we think for the financial system as a whole, it is prudent to attempt to anticipate risks.

The Agreement also brought together publicly available plans for how 188 countries intend to address the transition to a low-carbon economy and manage the consequences of warmer temperatures for the period of 2020-2030. In effect, this means there is limited room for denying that climate change is being taken seriously. These plans also strengthen the case for all investors to start assessing the resilience of investment holdings, and making adjustments accordingly.

Given the evidence of the impacts available today and the various forward-looking climate pledges, we think that in the future, it won't be credible to say 'we couldn't anticipate change' even if there is lack of belief that the changes needed to enable a low-carbon economy will be implemented. We consider the Paris Agreement to give *certainty* on the direction of travel and the destination, but not how long it will take to get there.

Long-term preservation of value requires including climate change into the decision, in our view

Assessing the financial implications of the shift to a low-carbon world and adjusting to higher temperature norms provides a means for investors to sense check the resilience of asset value and income generation against the changes to energy and economic structure that could occur from quicker than anticipated mitigation actions as well as more severe than expected physical events. We think preparing for outcomes driven by climate factors is key to preserving asset values and generating income over the long term.

There is a great deal of uncertainty around the speed of the transition, which is why the assessment is important. The points to understand in relation to the prospects for a low-carbon future are things like: what happens if the move to low-carbon is quicker than anticipated? How will assets respond? Is the financial system ready? The move to a low-carbon economy could potentially be disruptive if it is disorderly, for instance, high-carbon companies might not be able to provide the same level of dividend income, or there might be difficulty in getting out of assets at a reasonable price, or there might not be enough new low-carbon investment opportunities.

Although there is uncertainty, we think the financial sector needs begin assessment of climate change now

We think that Paris raised the bar in terms of how the financial sector must assess and respond to climate change. The long-time horizon of asset owners and their liabilities naturally prompts a better understanding of climate risks, which in turn should filter down to investment managers. Asset owners' key focus is to safeguard future capital values and aim to avoid value erosion.

Conclusion

Climate change is a well-established and pressing topic on the global stage. The challenges of dealing with climate change affect politics, economics and industry. We think that each player in the financial system has a specific responsibility in relation to implementing the Paris Agreement. Central banks have already begun the process, France has enacted its Energy Transition Law which requires enhanced climate disclosure and shareholders are becoming more vocal as well as more aware.

Asset owners need to preserve wealth over a long time horizon for future generations i.e. public and private sector pension schemes, and hence, in our view, it makes sense for them to consider how climate change affects financial factors. We believe climate change will play an increasing role in all decisions: issuing mandates, selecting investment managers, asset allocation etc. Over time, this will be a driving factor in raising climate awareness within finance.

Finance, and in particular the availability of capital, remains important for the successful implementation of the Paris Agreement, in our opinion. We think that climate factors, and how they affect future wealth preservation potential and the resilience of future returns, is taking on more significance for investment managers. This means that the understanding and disclosure of climate risk is crucial for all entities to play their part in the transition to a lower carbon world.

Assessing climate risk

- Changes to economic systems and infrastructure to cap carbon emissions present a risk to the demand for high-carbon sectors
- Changes to local weather systems because of global warming pose a disruption risk to sectors with globally diverse supply chains
- Progress on climate science raises civil society knowledge, and also legal grounds for dispute, increasing reputational and litigation risk

Relevance of climate risk

Climate impacts may disrupt income generation potential and reduce asset value

Risk management is a core competency for Board Directors everywhere. Standard risk assessments include looking at operations, profitability, legal, reputational, product and market risks and are a fundamental part of running a business. Now, climate risks are increasingly relevant to Boards because they are becoming a more important input across these standard risk factors. We think efforts to slow climate change disrupt the potential for value creation from high-carbon assets (e.g. fossil fuel commodities), as well as the ability to generate sustainable income from high-carbon goods and services (e.g. power generation sourced from coal). This in turn is relevant for portfolio risk management.

For example, *operational* climate risk factors include potentially higher costs because of carbon pricing, interrupted operations from greater health and safety standards in relation to potential extreme weather event, or interrupted operations from supply chain disruption. *Profitability* can be impacted by increased costs relating to climate factors, such as energy costs relating to utilities passing on carbon pricing. We examine how climate risks slot into risk assessment below, however we first identify the different types of climate risk.

Defining climate risk

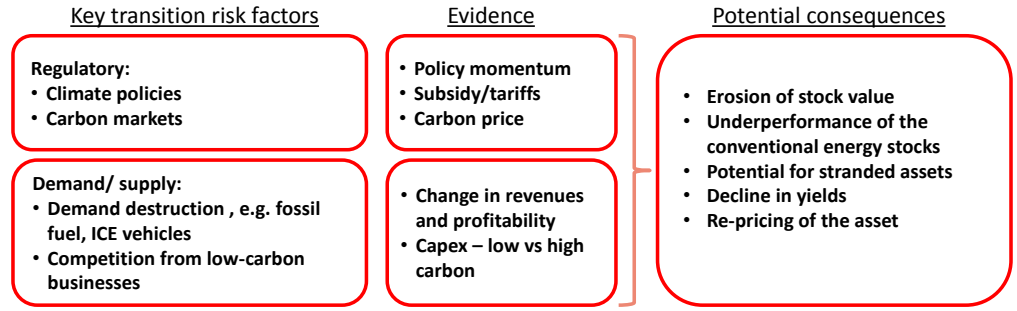
Mitigation

The Bank of England splits climate risks into Transition, Physical and Liability risks

We know that the first step to solve climate change is to halt and reverse greenhouse gases, a process referred to as mitigation. This is achieved by decoupling energy from growth (energy efficiency) and decarbonising the energy system. The overly simplistic answer to stopping annual emissions is to switch out of using fossil fuels in power, as well as decarbonising transportation and industry. If this occurred, the demand for fossil fuel commodities and products using fossil fuels would fall, resulting in surplus fossil fuel inventory which would depress prices and devalue assets. This notion of changing asset value and income potential is often referred to as transition risk.

Transition risk arises from the process and rate of adjustment from a high-carbon economy towards a lower-carbon economy which may result in the loss of value for certain types of economic activities or assets. For instance fossil fuel exploration/production, coal-based power generation, traditional petrol (internal combustion engine or ICE) cars.

Chart 3: Mapping the transition risk factors



Source: HSBC

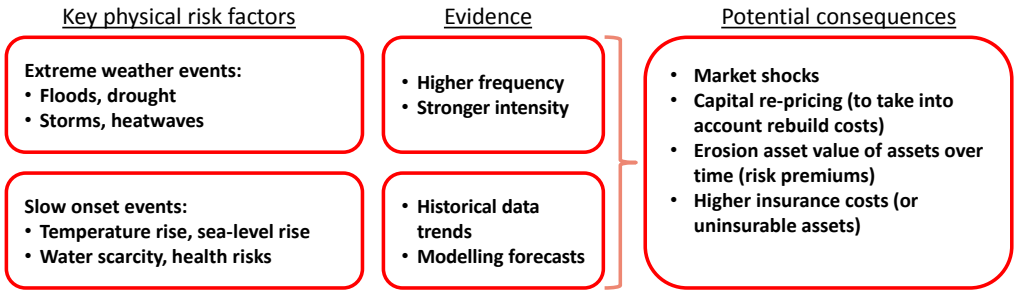
Adaptation

We think physical risks are most easily understood, followed by transition, then reputational risks

At the same time, the consequences of warmer temperatures give rise to a different set of risks related to changing weather norms. In short, as temperatures rise, more water is evaporated which gives rise to more intense and severe rainfall patterns, causing economic disruption from landslides and flooding in some areas, whilst other areas experience droughts. In the Paris Agreement, countries agreed that adaptation was a concerning issue to be addressed. These types of adaptation factors are commonly referred to as physical risk.

Physical risk is associated with the impacts of climate-related physical events (such as extreme weather or slow-onset events) on economic activities or assets, which may result in the loss of financial value (or an increase in insurance liability). For instance trade disruption, factory closure, property damage.

Chart 4: Mapping the physical risk factors



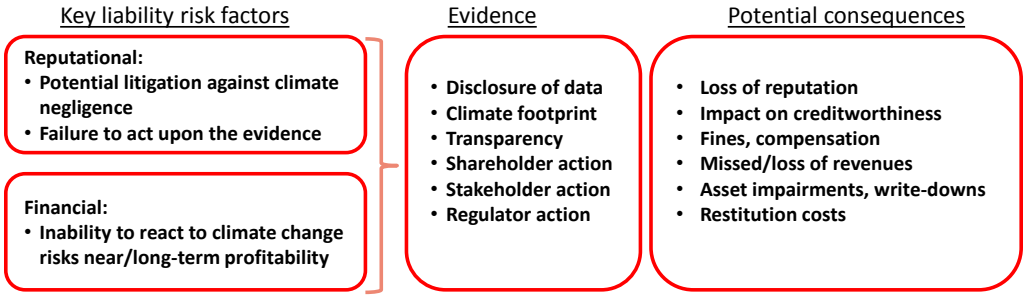
Source: HSBC

Reputational

As thinking around climate change develops and matures, there is an increased propensity for litigation responses in our view. This is mainly as a result of attributing the effects of climate change to the causes. We also expect academic thinking on climate change to turn to the societal impacts around health and livelihood, which can invoke emotional responses to social injustices resulting from climate factors.

Liability risk is the potential for future litigation proceedings in relation to financial loss as a result of negligence, such as ignoring the risks of climate change; deliberate inaction, for instance failing in fiduciary duty to act upon climate change knowledge; or wilful action which is taken despite awareness of the harm that excessive emissions might cause.

Chart 5: Mapping the liability risk factors



Source: HSBC

> **Oil explorers Soco International and Cairn Energy have been reported to UK regulators for allegedly failing to tell investors enough about the risks that climate change poses to their businesses.**
>
> ***Financial Times*, 22 August 2016**

The risks are summarised in real-world examples in the table below.

Table 3: Examples of climate-related risks that are already relevant

Type of risk		Description
Transition	*Sector*	
Regulatory	Autos	Norway and the Netherlands are initiating legislation to potentially ban the sale of internal combustion engine (petrol and diesel) vehicles from 2025.
Demand/supply	Coal	In 2015, global coal consumption fell 1.8%; the US used 12.7% less coal; China imported 35% less thermal coal and has an estimated 1.8bn tonne capacity surplus.
Physical	*Event*	
Extreme	Thai floods	Floods in October 2011 caused an estimated USD45bn in damage and losses, as well as severe global supply chain disruption.
Slow onset	Sea-level rise	The chances and frequency of a 1-in-100yr flood are higher. According to Hinkel et al, 2013, the value of assets below this height (i.e. 100yr water level) is USD17-180 trillion
Liability	*Company*	
Reputational	ExxonMobil	A coalition of 16 US states are investigating whether Exxon misled investors about the risks climate change posed to its business.
Financial	Peabody	The coal company filed for Chapter 11 bankruptcy in April 2016, citing "factors affecting the global coal industry, over production of shale gas and ongoing regulatory challenges."

Source: HSBC.

Climate risks are inter-dependent

More mitigation effort now (higher transition risk) means fewer extreme events in future (lower physical risk)

Another important consideration for investors to understand is how the likelihood of the risks changes in relation to each other. For instance, as a hypothetical example, if regulation around the sale of ICE cars were implemented at scale, i.e. globally, and quickly, e.g. in the next 5 years, the transition risk for the auto sector would be high. However, this would result in lower annual emissions, which could mean that the future physical consequences are less disruptive. Other climate-related risk factors include the impact of carbon pricing on profitability and demand for products.

The inter-dependency of climate risks means it is impossible to reduce all the risks to zero

We believe that the speed and scale of mitigation action has an impact on the likelihood and scale of adaptation risk in the future. The inter-dependency between transition risk and physical risk (i.e. that addressing one lowers the likelihood of the other), means that avoiding all climate risk is almost impossible in our view. Of course investors have different perspectives on the likelihood and time horizon of the risks playing out, but our baseline narrative for this report is that initiatives to limit warmer temperatures will be undertaken and that the disruptive consequences of warmer temperatures will be felt.

Box 4: Tipping points and climate change – a tipping point refers to a point at which there is a change to a system that goes beyond a defined state of equilibrium, usually such that there is no return. For example, in physics, a spring that is stretched so much that it cannot return to its original state.

In climate change, this refers to a sudden, irreversible (at least for hundreds of years) change to the earth's climate, that may accelerate emissions to levels beyond which the impacts are severe. For example, rising temperatures may cause permafrost (which stores vast amounts of carbon) to thaw, and hence release this carbon – in turn further accelerating climate change.

"Tipping points" such as permafrost loss, may accelerate climate risks

In addition, the tail risk event could be a sudden change in the likelihood of high transition and physical risk profiles. For instance scientists are exploring the possibilities around tipping points – the notion that there may be irreversible change to the climate system past a certain environmental level, caused by, for instance, arctic sea ice loss, or the destruction of the Amazon rainforest. If a tipping point was breached the response could be an acceleration of mitigation policy action combined with physical disruption in our view.

Businesses and climate risk

How are the risks factored into businesses today?

Businesses usually start looking at climate risks on a bottom-up operational or tactical disclosure basis

To date, much of the corporate response to climate change factors has been based on becoming operationally efficient. In other words, companies have been focused on ***minimising their contribution to climate change*** by setting CO_2 reduction goals, scaling up energy efficiency and implementing broad sustainability initiatives through in-house and supply chain operational processes. This made sense because policy implementation related to solving the climate problem, such as carbon pricing, was a bigger risk factor previously in our view.

> **Historically, companies have addressed climate risks by managing their contribution *to* climate change**

The disclosure of these initiatives meant that investors could measure and compare operational carbon intensity as a means to assess climate risks, and this remains important in our view. The rationale for this is to assess potential cost increases as a result of pricing carbon and the related externalities. Other operational issues to look at are areas such as changing health and safety frameworks as a result of physical factors like more intense storms.

How will the risks be assessed going forward?

We think bottom-up analysis will be combined with top-down strategic positioning

We expect bottom up initiatives, which remain important as a means to reduce GHGs, to be supplemented by a more strategic vision on climate, driven by the need to understand how the macro climate change risks are likely to play out. In other words, going forward, we expect companies to focus more on minimising the ***impact of climate change on the business.*** These are risks that are outside of their direct control, but that can be managed by long-term vision and strategic positioning.

> **Going forward, companies will also focus on the strategic impact *from* climate change factors on the business**

This is a difficult issue to assess since few companies a) set out how they incorporate climate factors into planning and strategy, and b) actually disclose this to the public. However, we expect this to develop over time into a key engagement area for investors.

We think companies undergo an evolution with the climate change thought integration process (Figure 3), beginning with initial awareness and a desire to minimise their carbon footprint, towards understanding the wider risk implications as well as long-term strategic opportunities.

Figure 3: Incorporation of climate change issues into business management

Source: HSBC

Investors and climate risk

In our view, investors should prepare for both tactical and strategic responses in relation to climate risks

Climate risks vary by sector and we set them out in Table 11 on page 34. We expect investor focus to evolve more towards the right-hand side of Figure 3 by concentrating on future strategy in relation to climate change dynamics. We explore this in more detail in chapter 4. At the minimum however, we think there are three high-level questions that are relevant to all companies.

4. **Metrics:** How are climate risk factors measured and assessed?
5. **Governance:** Where does overall accountability for climate change risks lie?
6. **Strategy:** How is climate change factored in to business strategy?

Conclusion

We believe climate change is an important risk to consider within financial markets as well as company operations. Climate risks have the potential to be significant value drivers – either negatively or positively – and hence need to be incorporated into risk management.

Climate risks can be broadly categorised into **transition** risk (which covers mitigation), **physical** risk (which covers adaptation) and **liability** risk (which considers reputation and finance). These risks are also inter-dependent because changes in one type of risk can affect others. For example, a jump in transition risk lowers the potential for physical risk. However, there are also potential tipping points which, in a climate context, could cause an irreversible change to the earth's climate.

As businesses evolve in their awareness and response to climate change, we think long-term strategic decisions will begin to take climate change into account – and alter business models as well as develop new products and services to take advantage of the opportunities that may arise. Although climate risks vary significantly between sectors, we consider climate-metrics, -governance, -risk management and -strategy to be relevant issues for investors to analyse.

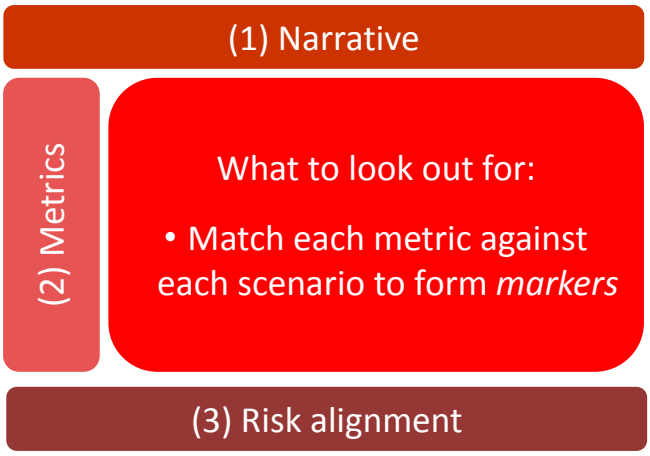
A climate risk analysis framework

- Our framework involves setting the narrative scenarios, identifying metrics, combining these to form progress markers and aligning risks
- The resilience of a system or individual entity in response to a negative event is usually measured by a stress test
- In a climate context this means *assessing* whether asset values will hold up to the adjustment towards a lower-carbon system

A framework mechanism: The Big Picture

Ultimately, what we are trying to achieve with this analysis is to design a framework mechanism that asset managers can use to better assess the risks related to future asset values, income generation potential and returns in the face of uncertain responses to climate change.

Figure 4: The framework for assessing climate risk profile



Source: HSBC

Figure 4 summarises the three steps to do this, which are choosing an over-arching narrative with scenarios of how the future might look, identifying relevant metrics that provide a basis for monitoring what is happening, and estimating what the intersection of scenarios and metrics means for climate risks across a portfolio. In addition, investors can tailor this for their own circumstances, such as beliefs on how the transition to a low-carbon economy will develop, as well as risk appetite and investment horizon. We also think this framework can equally be used as the basis for testing the resilience of an individual stock or the future health of government treasury receipts from the economy. We look at these steps in detail from page 24, but first we revisit concepts around asset value resilience.

The conversation among campaigners, and, to lesser degree investors, has recently turned towards stress testing in a climate context, but there is little clarity on what that really means. Our framework examines the resilience of an investment portfolio against the structural shifts that may occur during the transition to a low-carbon economy (such as changing norms to demand for high carbon goods and services), and adverse climate change impacts such as the consequences of warmer temperatures (physical factors such as extreme droughts and floods).

This is not quite the same as traditional stress testing, because the framework doesn't produce an individual value which encapsulates how much, in monetary terms, is at risk if a worst case climate event plays out. Part of the reason why we have adopted this framework approach is because at a system wide level, nobody really knows what the worst-case climate outcome is, or how it will ripple through the economy. Nevertheless the framework provides pointers on how climate negatives could play out and we expect that with more disclosure full stress testing will become more prevalent.

Stress testing for resilience

"Stress testing" usually assesses the consequences of the most pessimistic scenario

The idea of stress testing usually refers to assessing the resilience of a system or entity against a negative situation. Stress testing is not a particularly new concept and is now routinely used in the context of financial system stability. For example, tests currently capture the narrative about oil prices, which is relevant for climate solutions today, but over time, we expect tests to gradually incorporate more climate factors as the financial system works to plan for a low-carbon transition. In 2001, the International Monetary Fund produced a working paper on 'Stress Testing of Financial Systems', which set out the concepts and techniques of stress testing, issues around evaluating risks at the aggregated level of financial systems, and looked at the toolkit for conducting stress tests. The rationale then was that the financial system was growing ever more complex, and financial stability was thus ever more important for macroeconomic performance. It allows policy makers to assess banks' resilience to a range of adverse shocks and ensure they are adequately capitalised. In short, it is a tool to capture risks, with the aim of being prepared for them. The same rationale can be put forward for climate change in our view.

> **A [financial] stress test examines the potential impact of a hypothetical adverse scenario on the health of the banking systems and individual institutions within it.**
>
> **Bank of England**

Financial stress testing has advanced and evolved since the global financial crisis

Efforts on financial system stress testing were stepped up in the aftermath of the financial crisis with the aim of safeguarding the financial system. Table 4 shows that most of the Central Banks within the G20 already stress test local markets for financial stability.

Table 4: Financial stress testing within G20

Country/ region	Regulatory agency	Year	Coverage/ method
Argentina	Central Bank of Argentina	Annually	All financial intermediaries; covers credit, liquidity, interest rate and market risks over 24 months horizon
Australia	Australian Prudential Regulation Authority	2014	Thirteen largest Authorised Deposit-taking Institutions (ADIs); two scenarios focused on a severe downturn in the housing market
Brazil	Central Bank of Brazil	-	A corporate project is under way for supervisory stress test and individual bank's programme on stress test
Canada	Bank of Canada	Semi-annually	Financial System Review entailing scenario based risk and impacts assessment
China	People's Bank of China (PCB)	Regularly	The macro-prudential policy on forward looking provisions (2011) and macro-prudential policy on leverage (2015); cover commercial banks, private lenders, non-financial institutions with financial functions, etc.
EU	European Banking Authority	2009-11, 2014, 2016	EU- wide stress testing on micro-prudential level covering 123 banks across 22 countries in 2014
France		2009-11, 2014, 2016	11 major banks were covered by the EU-wide stress testing of 2014
Germany		2009-11, 2014, 2016	24 major banks were covered by the EU-wide stress testing of 2014
India	Reserve Bank of India	2015	Scenario based macro stress test covering all the scheduled commercial banks; credit, interest and liquidity stress tests are regularly carried out
Indonesia	Bank Indonesia	2014	Exchange rate depreciation, capital adequacy and liquidity risks of the banks
Italy	Bank of Italy	2009-11, 2014, 2016	15 major banks were covered by the EU-wide stress testing of 2014
Japan	Bank of Japan	Semi-annually	Financial Macro-econometric Model: included 371 institutions covering 10 major banks, 105 regional banks and 256 Shinkin banks in April 2016 report
Mexico	Bank of Mexico	Annually	Scenario based risk and their impacts on entire financial system (Financial System Report)
Russia	Bank of Russia	2015	In 2015 Q1, the Bank of Russia stress tested microfinance organisations (MFOs) for credit risks; Bank of Russia to hold in future stress testing at least once every six months under the extended method that also considers liquidity risks
Saudi Arabia	Saudi Arabian Monetary Agency	2015	Top-down macro-economic stress test of the banking sector; besides banks are also required to semi-annually perform their own stress test
Singapore	Monetary Authority of Singapore	Annually	Industry-wide stress test of financial institutions
South Africa		2012	The stress testing exercises were conducted in 2012 for the larger banks taking into account the domestic and international economic scenarios
South Korea	Financial Supervisory Service	2014	Testing of Korea's commercial banks and certain non-bank depository institutions; includes foreign currency liquidity and borrowing conditions
UK	Bank of England	2014, 2015, 2016	Macro-economic stress scenario spanning period up to 2020, traded risk scenario, misconduct cost stress; 7 banks with 80% of the outstanding stock of lending to the real economy (in 2016)
USA	Federal Reserve	Annually	Comprehensive Capital Analysis and Review (CCAR) and supervisory stress testing to assess the impact of stressful economic and financial market conditions; applicable on banks with assets over USD50bn and all the non-bank financial companies

Source: Financial Stability Board(FSB), Central Banks, and Financial Regulation Agencies

We think it is only a matter of time before climate-related financial risks are included in such tests since changes to how high-carbon assets are valued could have an impact on the overall stability of the financial system, through for example, loan defaults and impairments, asset write-downs or write-offs and also broader economic factors such as changing trade flows.

We do not think that *financial* stress testing and *climate* stress testing are fully analogous because, in a climate context, currently it is difficult to determine what the right question or series of questions to ask is. For example, the question "how much climate-related transition, physical and liability disruption can your financial assets take?" is not easily measured.

The challenges of stress testing in a climate context

Climate stress testing is fraught with challenges…

We think the assessment of climate risk is difficult for six main reasons:

1. climate-related indicators are relatively new to finance professionals;
2. quantitative indicators for measuring climate change, such as CO_2 levels, are generally reported less frequently than traditional economic, industry or company financial data;
3. the transition to a low-carbon world can take many forms (speed, pathways, configuration) which makes defining specific scenarios difficult;

4. the timing and magnitude of physical climate impacts is uncertain;
5. future human consequences remain largely unknown (e.g. migration for environmental reasons), making demographic assumptions difficult;
6. the cost of the transition, which has an impact on economic and political decisions, is difficult to estimate accurately because of the myriad of factors that can affect it.

…but we expect it to become much more commonplace

Nonetheless, over time, we expect measuring resilience to climate stresses in the financial system to become commonplace, in a similar way that stress testing for the financial sector has evolved. In the future, we anticipate banks, insurers, asset managers and companies to be required to disclose how well-prepared they are for climate-related risks. In turn, this requires them to understand and estimate how climate risks will play out.

Climate risk assessment is very diverse because there are multiple ways to deliver decarbonisation

In our view, the over-arching climate narrative will evolve in the future in response to more data, because new observations will show how the world is responding to the climate challenge, which in turn determines how the relationship between transition and physical risks plays out. *Financial stress testing* narratives have both qualitative and quantitative aspects. They include overall positioning statements such as 'long-term interest rates remain very low' and then apply a quantitative metric to apply the test e.g. 'the price of oil troughs at USD20 per barrel, reflecting further slowdown in world demand'.

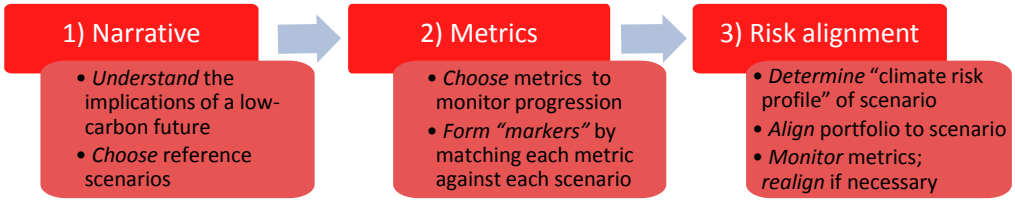
The narrative to assess the resilience of portfolio value in a *climate context* is dependent on multiple factors, which are interrelated, leading to a broad range of possible outcomes – as opposed to a single question (e.g. what happens if global GDP falls by 5%). This is because the means of decarbonisation can be delivered in a variety of different ways by a diverse group of sectors such as power, transport, industry, buildings and agriculture.

Our framework for assessing climate risk

Examining investment disruption against transition, physical and liability risk

Our framework examines the potential value disruption to an investment portfolio against the structural shifts that may occur during the transition to a low-carbon economy (such as changing norms to demand for high-carbon goods and services), and the adverse climate change impacts such as the consequences of warmer temperatures (physical factors such as extreme droughts and floods). We think this broad framework can equally be used for testing the resilience of a portfolio, an individual stock or the future health of government treasury receipts from the economy.

Figure 5: Our climate assessment framework in a three-step sequence



Source: HSBC

Step 1) Narrative: The implications of a low(er)-carbon future

Step 1 of the framework consists of thinking about what *could* happen in the future. In effect, deriving the narrative means **developing a view of how "low-carbon"** the future global economy will be, in other words, it is an estimate of the degree of "low carbonness" of the future.

First, understand how a low-carbon world will be different from a business-as-usual world

In a climate context, we think the first thing to do is to take a view on how *business as usual,* or BAU, will change in response to mitigation action and adaptation consequences. What does the central narrative for a low-carbon future look like? An oft-cited future, for example, is a 2°C world, but greenhouse gas emissions could be above or below the emissions threshold for a 2°C world at any given time, and this has implications for the eventual rise in temperature, as well as the timeframe of the low-carbon transition.

If, for instance, you believe that the world will develop and grow mostly in the same way that it has in the past, so that temperature rises will be greater than 2°C, then your central narrative and resulting scenarios would lean towards physical impacts and adaptation. If you believe temperature rises will be limited to 1.5°C then your narrative would lean heavily towards mitigation action in the form of strong political will and strict regulation.

Narrative and scenarios

A low-carbon future can take many forms because it is dependent on the interaction of so many different factors

Our central narrative is that the future will be a low-carbon one, where the aim is to try to keep within a 2°C temperature rise – a so-called 2°C world (Box 4). We expect the world to improve energy and carbon efficiency by reducing dependency on energy for economic growth and use less carbon-intense fuel sources, while, at the same time, scaling up natural and manmade sinks to capture CO_2, such as reforestation and carbon capture and sequestration.

> **"The transition to a 2°C world could result in varying end economic configurations of energy, industry, agriculture**

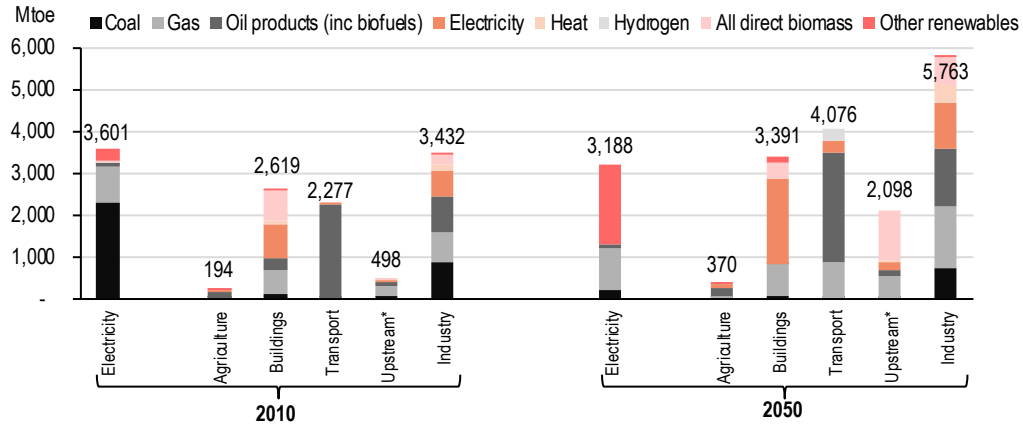
However, differing country exposure to high and low-carbon resources (e.g. coal versus water or solar for power), and natural sinks (e.g. forest) means the lowest cost option for countries to decarbonise varies significantly. In addition how these resources contribute to the economy is an important point to consider (e.g. export revenues, tax contributions) which means there are many different possible scenarios, or configurations of how the low-carbon future plays out. We think the narrative requires understanding the degree of "low-carbonness" of the future (e.g. 'a 2°C / 1.5°C world' or 'business as usual'). Once the central narrative is set – in this case 'the future is low carbon' – scenarios can be derived.

Box 4: A 2°C world: *A 2°C world refers to a future where the global average temperature increase of the earth since pre-industrial levels as a result of anthropogenic emissions of greenhouse gases is limited to a maximum of 2°C.*

We take a 2°C world as the central reference scenario because, firstly, the IPCC found in 2013 that beyond 2°C, the physical impacts would be more severe. Secondly, 2°C is the main mitigation aim of the Paris Agreement. We note however, that the Paris Agreement also pursues efforts to limit warming to within 1.5°C, and that consequences of a 1.5°C are likely to be felt, and negative, for some countries.

What would a 2°C world look like? There is no set definition of what a 2°C world would look like, because the transition to this world could take a number of pathways and result in varying *end economic configurations* (of energy, industry, agriculture etc.) and scenarios of varying complexity. For example, Chart 6 shows what energy demand in a 2°C world could look like. These estimates are based on analysis HSBC commissioned University College London to complete for *'Energy beyond Paris'*, November 2015. (Please contact your HSBC representative or email *Research.Direct@hsbc.com* for more information on how to access the full report)

Chart 6: Energy demand by sector in 2010, and consistent with a 2°C world in 2050



Source: UCL - based on modelling commissioned by HSBC for the report *Energy beyond Paris* (November 2015). Please contact your HSBC representative or email Research.Direct@hsbc.com for more information on how to access the full report.

Many organisations already provide bottom-up projections for possible scenarios (i.e. economic configurations) of how the future might look. For example, industry and academic organisations have published models of the future, as have companies within the energy and resource sectors. Table 5 shows a summary of these.

These are a useful starting point, but are just "visions of the future" and in most cases come with a "health warning" since they are based on a world view from the vantage point of either the company or the entity which may have a vested interested in what the future looks like.

Table 5: Scenarios of the future according to various energy companies or agencies

Scenarios	2°C achieved	Carbon Neutral by	Approach	Assumptions
Shell New Lens				
Mountains	No, 2.4	2100	Based on inputs; government intervention; not target based	- government policy significantly influential on society, energy and environmental pathways -cleaner burning natural gas backbone of energy systems, coal still prominent
Oceans	No, 2.7	2100	Based on foreseeable market forces; not target based	- shaped by market forces and civil society - Coal widely used until mid-century; GHG reduced by combination of CCS and solar
Accelerated zero emissions scenario	Yes	2070	Outcome (end bound) oriented scenario; target of limiting to 2°C	- Zero emission technologies, including renewables and nuclear; high energy-efficiency standards in building design and operations - Reliance on electricity and hydrogen in transport - CCS only viable route to eliminate the bulk of emissions from activities
IEA				
World Energy Outlook - 450 Scenario	Yes	NA	Outcome (end bound) oriented scenario; target of limiting to 2°C	- Concentration of GHG stabilises at 2100 around 450 ppm to limit to 2°C - more widespread and aggressive carbon pricing; reaches USD140/tonne in 2040 - stringent climate policies reduced long term global coal demand; increased energy efficiency sees energy consumed per dollar of GDP decline by 45%
BP				
Energy Outlook 2035	No, -	NA	Based on foreseeable market forces; not target based	- Growth in energy (1.4%p.a.) till 2035 curbed by faster gains in energy efficiency - Fossil fuel dominant; Gas, renewables grow rapidly; slowdown in coal - carbon emissions likely to increase; carbon pricing to play crucial role in curbing
Exxon				
The Outlook for Energy: A View to 2040	No, -	NA	Based on foreseeable market forces; not target based	- Global demand for energy to rise by 25 per cent (2014-2040); Global energy-related CO_2 emissions likely peak around 2030; OECD to lead this shift, China plays significant role - CO2 intensity of global economy to be cut in half by 2040; 40% of growth in global energy demand to be met by gas
UCL				
HSBC 2°C Scenario	Yes	NA	Outcome (end bound) oriented scenario; target of limiting to 2°C	- Technology transfers between regions facilitated; trading of CO_2 emissions fully permitted to keep within carbon budget - Fossil fuels exit from power generation mix; however they remain part of a cost optimal energy system - Large investments in nuclear and renewable; CCS

Source: Various Energy Scenarios reports , HSBC

Our reference scenarios

The more factors included, the more detailed the scenarios become

The level of detail of the scenarios will depend on how many factors are incorporated to the economic model that is used to identify what could happen within the overall narrative. The level of detail of a scenario is almost unlimited, but will likely vary according to the type of instrument that the climate risk analysis is for. For example, a climate risk assessment for the autos sector could include setting out the range of future carbon intensity per kilometre travelled by car model, whereas a climate risk assessment for the UK equity market might look at the dependency of the market on high carbon companies for instance. Nonetheless, we think that for each assessment it is important to set out scenarios. For our illustrative purposes we have chosen three broad reference scenarios of: a well-below 2°C world, a 2°C world, and a well above 2°C world.

Our reference scenarios are based on the expected temperature rise

- **1) Well-below 2°C:** Temperature rises in the future are limited to well-below 2°C as a result of rapid changes in the global economic system to halt and reverse GHGs from power, transport, industry, buildings and agriculture. The disruptive physical impacts of droughts and floods are less severe and are mainly responded to (rather than prepared for).
- **2) 2°C:** Temperature rises are limited to within 2°C as a result of policy implementation and current innovation to slow down GHGs. Physical disruptive impacts are apparent and adaptation planning is in place to address these.
- **3) Well-above 2°C:** Temperature rises far exceed 2°C as a result of business as usual economic development. This leads to severe disruption from physical consequences such as loss of economic infrastructure as a result of natural disasters, e.g. flooding and sea-level rise. Livelihood loss in the most hit regions leads to large scale population migration.

Implications for risk assessment

On page 17 we noted that how the risks relate to each other determines the thinking around the likelihood of the event, which makes climate risk assessment complicated. In simple terms, a quick transition to a low-carbon world would mean higher transition risk today and lower physical risk tomorrow (because GHG emissions are reduced), whereas a slower energy transition means less transition risk today, but higher physical risk tomorrow (because GHG emissions keep on rising).

Or in another example, hypothetically, you might believe that GHGs in the power sector will be reduced by regulation which mandates a quick uptake of renewables. In this case, GHGs would be reduced, and the physical risk in the future would be lower. If, however, the shift comes from a move to gas instead, then GHGs are not reduced as quickly (as they would be from renewables) so the physical risk in the future would not be as low as first thought. We think the urgency of halting emissions means that effort will be targeted across all sectors, but for most countries power is the starting point.

In summary, the first step of the framework is to understand what could happen in the future in relation to climate change, and in that context choose reference scenarios which form the basis of the risk alignment process later.

Step 2) Metrics: Providing a snapshot of the real world

Metrics help to signpost which scenario is playing out

Step 2 of the framework involves thinking about how to monitor the journey towards the future, and choosing metrics that provide a real-time snapshot of climate progression. This allows us to form a judgement today on which scenario is most likely playing out. We think this enables a more accurate risk alignment between transition, physical and liability risk.

Metrics, mapped against scenarios, help us to determine what to look out for as the future plays out. For example, metrics indicate whether political will translates into political action that is consistent with a 2°C world, or whether the energy system is moving away from fossil fuels. This allows investors to sense check how reality is progressing against our scenarios. Please note that metrics are not scenario-specific i.e. the same metrics cover all scenarios.

We think monitoring the status of the narrative and scenarios is important to assess because the types of climate risks will change in response to how economies develop and climatic impacts play out. Metrics are also useful for anticipating future 'triggers' i.e. the events that make your vision of the future become a reality. In the next sections we set out different types of metrics.

Influencing the path of GHG emissions – managing transition risk

Transitioning to a low-carbon future involves emitting less GHGs, while at the same time, absorbing more GHGs

Enabling a lower carbon future necessarily involves a reduction in the volume of GHG emissions (CO_2,) methane (CH_4), nitrous oxide (N_2O), and F-gases reaching the atmosphere. Broadly speaking, this can be achieved in two main ways:

1. emitting less GHGs – reducing the volume produced in the first place
2. absorbing more GHGs – reducing the volume which actually reaches the atmosphere

In reality, it is likely to be a combination of these two – trying to emit less while at the same time trying to absorb more GHGs. Ideally therefore, metrics that monitor evidence of the two points above are useful for measuring if what *could* happen under the scenarios actually *is* what's happening on the ground. In addition, we think there are two types of metrics to monitor. Firstly, metrics that reflect an *active response* to enabling change, such as policy for carbon pricing. These are important because they signal a political will for transition. Secondly, metrics that are, in our view, a *passive response* or a function of other factors, e.g. lower emissions growth that is a result of lower energy use because of economic slowdown. These are important because they signal how quickly a response is happening, important in itself for continued country collaboration on implementing the Paris Agreement.

Tracking both active and passive metrics is important because it gives more clarity on the interaction between transition risk, physical risk and liability risk i.e. the transmission mechanism between the different types of climate risk.

Tracking *active responses* to gauge *political will*

Active response metrics reflect the *political will* to transition to lower-carbon

The political will to create a favourable operating environment for companies to deliver the solutions for a low-carbon economy is important because it affects the pace of change. We categorise the key areas to monitor in relation to active responses as: regulation, energy mix, climate policy and carbon pricing (Table 6). We believe that monitoring these can give a good indication of the strength of political will to transition to a lower-carbon economy.

These metrics are by no means perfect because sometimes regulation does not generate the desired outcome. For example, despite a moratorium on logging in many places, illegal logging can still take place. Nonetheless starting to track these indicators now will start to provide time series evidence for the future.

Table 6: Types of active response metrics - the strength of political will to transition

Indicator	Source	Frequency	Comment (usefulness etc.)
Regulation – demonstrates the will of governments to solve the climate issue through the direct powers available within their countries			
- Global	GLOBE, UNFCCC	Annual	GLOBE tracks momentum of climate-related policies. UNFCCC process - Paris Agreement (implementation, follow up).
- National	National	Ad hoc	Key countries are China, US, EU, India. National regulations may dictate the speed of transition.
- Sectoral	Ad hoc	Ad hoc	Key globally connected sectors include Aviation (ICAO), Shipping (IMO), Technology (agreements to limit other GHGs).
- Forestry (logging, reforestation, afforestation)	National, FAO	Irregular; Global every 10yrs	Key countries are: Brazil, Indonesia, DR Congo. Deforestation contributes to large amounts of emissions, whilst reforestation acts as a carbon sink.
Renewable Energy – shows the willingness (and ability) of countries to transition away from fossil fuels to other less carbon intense energy forms			
- Installed capacity of REN	BNEF; National	Annual	Give an indication of potential displacement of energy emissions. The price per watt of installation for REN also important.
- Proportion of REN in actual generation	BNEF; National	Annual	Indicates the penetration of REN into energy systems as well as the potential to shut down fossil-based energy. Related tariffs and subsidies should be monitored too.
- Renewable Portfolio Standards	National	Ad hoc	Usually regulated, these show an intention to decarbonise the energy mix.
- Grid investment (interconnections)	National	Ad hoc	Tracks policy or planned spend on enabling grids to cope with REN capacity (distribution and storage)
Climate policy – demonstrates the ambition levels of governments to solve the climate issue by setting targets and allowing the best means (market forces or regulation) to achieve these targets			
- National communications to the UNFCCC	UNFCCC	Varies	Specific deadlines for Annex 1 Parties; every four years for non-Annex 1 Parties
- Revised NDCs according to the 5yr cycle	UNFCCC	5yr cycle	Long-term carbon targets of a country with indicators of which sectors might be in line for regulatory change.
- Carbon neutrality goals	National, companies	Ad hoc	Which countries and companies plan to be carbon neutral in the long term, and how will this be achieved (CCS, domestic vs international offsets)
Carbon pricing (both taxes and trading) – indicates the will to regulate as many business and as much of global GHG as possible. The price is determined by market forces but may also be set with floor prices and collars etc.			
- Number/coverage of schemes	World Bank, IETA	Annual	The more carbon is regulated, the greater the incentive to transition towards lower-carbon activities.
- price of carbon within these schemes	Local	Regularly	Although price is a function of market activity, it is sometimes controlled by setting floor prices or auctions.

Source: HSBC

Tracking *passive responses* to gauge *economic influences*

Passive response metrics demonstrate the speed of transition, taking into account economic influences

Similarly, we categorise the key *passive* responses as: energy, climate and finance (Table 7). We think that monitoring these give an indication of the speed of the transition and other economic influences that could act as a catalyst or a drag on disruptive technologies. These responses are related, for example, the strength of political will can influence the speed of transition but economic influences also feed back into both of these. Commodity prices, such as oil, are largely based on supply-demand forces but governments can sometimes interfere with restrictions or subsidies, which alter the price and also affect the speed of transition.

Table 7: Passive response metrics - economic influences and speed of transition

Indicator	Source	Frequency	Comment (usefulness etc.)
Fossil fuel energy – the supply and demand for fossil fuels is mainly a function of economics and price			
- Production of fossil fuels (coal, oil, gas)	BP, National	Annual	Indicates industry confidence on the future of fossil fuels (E&P) and whether the industry is ready to diversify its strategy.
- Consumption of fossil fuels (coal, oil, gas)	BP, National	Annual	Indicates the strength of demand, and whether it has been replaced by something else.
Climate economics – countries can set targets, but these can be met or missed for various economic reasons e.g. recession, lower GDP or the transition of an economy to services			
- Annual emissions of CO_2 and other GHGs	WRI, BP, IEA, UNFCCC, National	Annual	Many climate targets are based on emissions reductions. This indicator shows the rate of spend of the carbon budget and how much remains.
- Volume of offsets available	CDM database	Annual	Measures 'avoided emissions' and indicates the potential for carbon neutrality.
- Decrease in energy intensity of economy	Calculated	Annual	Indicates progress of global/national decarbonisation of the economy.
- Decrease in the carbon intensity of energy	Calculated	Annual	Indicates the rate of transition away from high-carbon towards lower-carbon energy - globally and nationally.
Finance – many national targets are conditional on external support, but whilst public finance can provide some of the funds, private funds are also required			
- Flows of 2°C finance	World Bank	Annual	Something to do with developing countries, adaptation and the willingness of developing economies to grow on a lower-carbon trajectory

Source: HSBC

Tracking *physical responses* to gauge how the earth is changing - managing physical risk

Physical indicators show how the earth is responding to emissions – and the rate at which it is warming

Scientists have been using satellite monitoring to assess changes to the earth's climate since 1979. The first Intergovernmental Panel on Climate Change assessment report (AR1) from 1990 addressed the potential responses of various systems (ocean, land, cryosphere, etc.) to the factors that "may affect climate change during the next century, especially those which are due to human activity". As an aside, in the same report, it predicted that "the likely global mean temperature rise would be about 1°C above the present value by 2025". In fact, the annual average global land and ocean temperature anomaly already reached 0.9°C in 2015, according to NOAA. The indicators below are used to track physical changes and are commonly defined indicators of a warming world.

Table 8: Physical indicators of a warming world

Specific indicator	Comment	For warming
Atmospheric concentration of CO_2	CO_2 molecules trap heat, so a useful indicator of future warming	Increases
Globally averaged land-sea temperature anomaly	Effectively the temperature of the whole earth - measures the anomaly (i.e. change) from an average time period	Increases
Global land surface air temperature anomaly	Just the temperature anomaly of the air above land (land heats up more readily than water)	Increases
Global sea surface temperature anomaly	The temperature anomaly of the surface of the sea (in the water) i.e. ocean surface water	Increases
Marine air temperature anomaly	The temperature anomaly of the air above seas (i.e. the air just above the sea surface)	Increases
Ocean heat content anomaly	Indicates how much heat energy is being absorbed by the oceans	Increases
Lower tropospheric temperature anomaly	Indicates how much heat energy is absorbed at altitudes below 12.5km	Increases
Specific humidity anomaly (marine)	Indicates the interaction between water (evaporation) and air	Increases
Mean sea-level rise	Shows the impact of climate change in a slow onset event	Increases
Northern hemisphere snow extent	Maximum usually in February - snow reflects heat energy back into space	Decreases
September month Arctic Sea ice extent	Minimum usually in September - Artic is warming faster than other areas	Decreases
Global glacier mass balance	Indicates rate of glacial retreat (or advance). Glaciers are important sources of freshwater	Decreases

Source: HSBC (actual data is available from meteorological agencies such as NOAA, UK Met Office, etc., and various academic institutions)

We think it is important for investors to check these indicators on an annual basis to assess the balance between the likelihood of transition and physical risk. If these physical indicators are worsening, then the potential for the impacts (extreme weather, droughts, floods) of warmer temperatures are higher, and the real economy risks from disruption is higher – this could spur the potential for tightening regulation, which could ultimately also lead to higher transition risk. Earlier we also pointed out that there could be a step change in transition and physical risk assessment if one of the indicators above changed so severely that the climate system was permanently disrupted. These "tipping points" should also be monitored.

Determining "markers" (what to look out for) – using metrics and scenarios

Matching metrics with scenarios determines "markers" or "things to look out for"

Next, we set out an expected storyline for each metric against each scenario, which helps us determine "markers" or "things to look out for" in each scenario. This also helps to generate the baseline view for climate risk alignment, which we do in step 3.

Markers are a *qualitative* judgement on the likelihood and timeliness of a metric under each scenario. For example, if you believe in a 2°C world, then the *likelihood* of more regulation in the *nearer term* is *higher*, however if you believe a 2°C world won't happen, then the *likelihood* of more regulation is *lower* or possibly pushed out to a *longer timeframe*.

Markers are established by taking a metric (e.g. regulation) and thinking about what would happen to it under each scenario. Table 9 shows this for our reference scenarios and our broad categories of indicator. We think these are important because they provide some assurance that portfolios are aligned to the "correct" scenarios i.e. the one that is playing out.

Table 9: Matching metric against scenario determines "markers"

	What to look out for, by metric, in each reference scenarios		
	Well-below 2°C	**2°C**	**Well-above 2°C**
Gauging political will – active metrics			
Regulation	New regulation is rapid, sudden and disruptive	New regulation is brought in at a modest, orderly pace	BAU or new regulation is very slow
Energy - REN	Targets for REN penetration are high and rapid	REN comes in "naturally" as a result of market forces (costs etc.)	Enthusiasm for REN slows because fossil fuels are cheaper?
Climate policy	Shortening of the cycle, significantly raised ambition levels.	On time submission, with gradual raising of ambition levels and scrutiny	Weakening of ambition levels with each successive report, less initiatives.
Carbon pricing	Rapid adoption of carbon pricing with rising carbon price.	Adoption of carbon pricing schemes with mechanisms in place to drive up the price	Abandoning of carbon pricing schemes, pointlessly low carbon price
Gauging the speed of transition - passive metrics			
Energy - Fossil Fuels	Rapid decline in consumption which leads to associated decline in production	Consumption growth slows and then declines slowly over time, leads to production oversupply	Big increase in both production and consumption
Climate economics	Rapid decrease in net emissions and intensity indicators	Slowdown in emissions growth (towards a peak) then decline; declining intensity indicators	Increase in net emissions, stagnant or rise in intensity indicators
Finance	Large volume of flows between countries	Volumes grow towards UNFCCC agreed levels by 2020, 2025 and beyond	Decrease in flows (or broken promises)

Source: HSBC

In summary, metrics and markers provide a status snapshot of how the world is progressing in relation to the scenarios set out earlier. The next step of our framework is to use this information to align investment portfolios with climate risk.

Step 3) Risk alignment: climate risk profile

The first two steps provide the basis to understand and assess climate change and its development using scenarios and metrics. The third step is to link this back to climate risks (transition, physical, liability) in order to work out which scenario the investment portfolio is most aligned to, which in our example would be well below 2°C, 2°C or well-above 2°C. If the existing investment portfolio risk alignment is not consistent with future expectations of climate risk then adjustments can be made, such as by reducing exposure to high carbon sectors. This initial risk alignment also provides the backdrop for future climate risk assessments. A summary example of linking risks to scenarios is set out in table 10.

Table 10: Mapping scenarios with climate risks

	Reference scenarios - temperature rise of the future		
Climate risks	**Well-below 2°C**	**2°C**	**Well-above 2°C**
Transition risks			
Regulatory	Increase significantly and disruptively High likelihood, high impact	Increase but smoothly	Minimal as changes are limited Low likelihood, low impact
Demand/supply	Increase significantly and disruptively High likelihood, high impact	Increase but smoothly	Usual risks associated with economic influences
Physical risks			
Extreme	Manageable risk Low likelihood, localised impact	Increase (frequency and intensity) quickly at a cost	Rapid increase in frequency and intensity, very costly High likelihood, high impact
Slow onset	Manageable risks	Magnitude of increase is costly	Large increase in magnitude and intensity, very costly
Liability risks			
Reputational	Severe and impactful	Growing	Limited
Financial	Severe and impactful	Growing	Limited

Source: HSBC.

For example, a 'well-above 2°C' scenario has a risk profile weighted towards physical risks whereas a 'well-below 2°C' scenario is weighted towards transition and liability risks. As time goes by, and a scenario evolves, its risk profile across transition, physical and liability risk is also likely to evolve.

Identifying potential value disruption: Now, this information can be used to assess the portfolio alignment to scenario, and therefore the risks associated with those holdings. We think all sectors are exposed to at least one of the three risk categories related to climate change above, however unsurprisingly some sectors are more exposed than others. Also, within high risk sectors, such as utilities, differentiated business models within the sector mean that the risks profiles vary.

Table 11 overleaf summarises what the main transition, physical and liability risks are by sector. In addition, we apply our own view on the exposure, sensitivity and adaptability capacity of the actors within the sector to these risks.

- **Exposure (E)** reflects the potential volume of assets subjected to a specific climate risk.
- **Sensitivity (S)** indicates the potential degree of financial loss related to a specific climate risk.
- **Adaptability (A)** notes the potential for the sector to take effective action to respond to or mitigate a specific climate risk.

For each sector, we assign a high (H), medium (M) or low (L) assessment next to the risk. For example, for the energy sector, under transition risk, the exposure is *high*, the sensitivity is *high* and the adaptability is *medium*.

Table 11: Summary of sector climate risk factors and vulnerability (this is how the climate risks translate into sectors)

Sectors	Transition risk			Physical risk			Liability risk		
Energy	Impact of efforts to de-carbonise the energy system; carbon intensive systems (coal) could face lower demand, with transition to low carbon systems (coal to gas) as a short-term measure			Damage of energy systems (oil rigs, nuclear power plants etc) from climate impact events (storm surge, sea level rise etc.); disruption in thermal power plants due to water scarcity or water that is too warm			Public litigation: governments may be directed to raise climate ambition and undertake measures to reduce emissions. High-carbon at risk by not changing strategy or investing capex in more high-carbon despite long-term shift away from these		
	E-H	S-H	A-M	E-H	S-M	A-M	E-M	S-M	A-M
Metals & Mining	Boost in demand for metals and minerals related to the transition to a low carbon economy in: 1) Renewable power physical structures 2) Building sector efficiency 3) Transport sector efficiency. Potential of value destruction because of regulation. Carbon pricing and rising energy costs could erode profit margins.			1) Extreme climate events would disrupt input materials (feedstock), make assets inoperable (inundation), curtail production, and limit efficiency. 2) Sea-level rise may affect port availability, interfering market linkages and increasing transport costs. 3) Critical inputs (e.g. water and energy) facing climate constraints could mean rising costs and limit operations.			Exposure to litigation due to mining activities damaging local ecosystems and causing public health risks (air/ water/ soil pollution)		
	E-H	S-M	A-M	E-H	S-H	A-L	E-H	S-M	A-M
Chemicals	Renewable feedstock, carbon pricing through tax/ cap/ trade, regulations for energy efficiency and reduction of emission footprint. Product innovation driven by requirements from building / industrial insulation and packaging sectors and need of composite material for vehicles so as to improve the energy efficiency			Fossil fuel based feedstock supply, production plants and logistics are exposed to extreme weather events. Water intensive processes could face constraints			Chemical plants could be responsible for pollution of local air, water and soil which could become a health concern. Chemical production processes are highly energy intensive (total energy related CO_2 emissions from chemical industry sector is 5% of global energy related CO_2 emissions)		
	E-M	S-M	A-M	E-M	S-L	A-M	E-M	S-M	A-H
Utilities	Increasing share of renewables (solar and wind) could result in significant investment shifting from centralised system to more complex and distributed structure, resulting in increased costs. Shift in demand could impact margins as well as higher energy efficiency requirements.			Higher incidence and intensity of extreme events could result in stress / breakdown of cooling power & grid systems, and other infrastructure loss. Higher temperatures could result in higher demand but less operable assets. Potentially higher and more frequent repair costs to maintain service quality			Inaction and lack of transparency on mitigating carbon emissions may lead to litigation. Fines may arise if service targets are not met, or tighter efficiency regulations are missed		
	E-H	S-H	A-M	E-M	S-M	A-L	E-L	S-M	A-M
Consumer Goods	Increased costs due to changes in consumer behaviour or preferences, in order to adapt to climate change (personal hygiene, lighter clothing). Shift in supply chain models (just in time vs inventory stockpiling). Stricter climate standards demanded by consumers could increase costs.			Extreme events could increase risk to supply chains, product delivery, or loss of manufacturing facilities, retail stores and disruption in operations. Specific growing (cotton) and buying seasons (e.g. winter) could be decimated because of extreme weather events (e.g. heatwaves, droughts).			Production plants could be responsible for pollution of local air, water and soil which could become a health concern. Pressure on well-known brands to contribute to the low carbon transition poses a reputational risk.		
	E-L	S-L	A-H	E-M	S-M	A-L	E-M	S-M	A-H
Industrial Goods	Increased policy focus on sustainable manufacturing process across building products, construction and engineering resulting in supply chain disruptions and increased costs to construction, and regulatory risks. Improved energy efficiency regulations and greater procurement costs could impact margins.			Infrastructure, supply chain more susceptible due to unprecedented weather events, increased energy efficiency standards to make inventory (engines, control systems, traditional materials) increasingly obsolete			Higher cost of insurance risk transfer instruments, or potentially uninsurable assets.		
	E-M	S-M	A-M	E-M	S-M	A-M	E-L	S-L	A-M
Financials	Pricing risk- arising because climate change elements are not incorporated into risk assessment and lending calculations. Increased scrutiny of indirect emissions for companies.			Project cost escalation due to changes in weather patterns. Re-insurance business could face business disruption, solvency / liquidity and property damage across assets / geographies due to extreme climate events. Higher cost of business continuity.			Regional climate extreme events may result in insurers carrying substantial residual risk and facing liabilities in claims and litigation. Perception of hindering the low-carbon transition or financing high-carbon is a reputational risk.		
	E-L	S-L	A-H	E-M	S-M	A-M	E-H	S-M	A-M
Transportation	Changing customer demands, increase costs due to ETS and emission based tax on fuels. Increasing requirements to improve fuel efficiency across road, aviation and marine. Disruption from new technologies (e.g. EVs)			Service disruptions from the impact of extreme events (floods, storms etc.) on infrastructure (bridges, canals, ports); loss of assets or need to upgrade facilities to cope with more frequent or intense adverse weather (storm surge, heatwaves, etc.)			Litigation risk from non-compliance of energy efficiency or emission reduction regulation. Penalties from failure to ensure service and infrastructure compliance with climate resilience directives. Reputational pressure to be more efficient		
	E-H	S-M	A-M	E-M	S-M	A-M	E-L	S-M	A-M
Information Technology	Increased electricity cost could affect supply chain. Higher demand for energy efficient products to reduce energy consumption and ensure compliance with regulations. policy regulations on efficiency could impact manufacturing process.			Increased incidences and intensity of extreme events are a risk to assets located in certain environments (e.g. flood plains, urban); increased saline corrosion of coastal infrastructure (broadcasting towers, etc. Physical damage to building, network, infrastructure, etc. from extreme events, or interruption of materials supply and manufacturing operations.			Loss of personal / financial data of consumers due to loss of data centres may result in litigation costs. Cost of insurance may increase or some assets may become uninsurable Failure to deliver products and services consistent with a low-carbon world could result in reputational risk.		
	E-L	S-L	A-H	E-M	S-H	A-H	E-L	S-M	A-H

Source: HSBC

The table above gives a high level of risk associated with the narrative that the future will be a low carbon one. Breaking down the risks one step further would align them to scenarios. For instance within energy, generally the transition risk is greater for coal exposed companies than gas, but if the markers point to a below 2°C world, then the transition risks related to gas increase.

Over time, the evolving reality will naturally result in risk profile adjustments across transition, physical and liability risks. For example, in monitoring, say, regulation, if you were expecting it to come in the 'well-above 2°C' column, and in fact, it comes in the '2°C' column, then you would need to reassess your position because the climate risks would also have shifted.

We note the metrics we are using to establish markers are likely to move *in tandem* i.e. if political regulation moves towards the left (well-below 2°C), then it is very unlikely that climate policy will move towards the right (above 2°C) – it is much more likely that all indicators of political will would shift in the same broad direction. This is helpful because there is likely to be incomplete data so we can use proxies.

We think that this testing framework should be conducted regularly so that it allows for any shift in policy and regulation to work its way through the global economy.

Conclusion

This chapter sets out a framework to enable investors to assess climate risk and map these to portfolios accordingly. For us, the narrative is that the world will shift towards a lower carbon economy, and our main reference scenarios are those consistent with a well-below 2°C, a 2°C and a well-above 2°C temperature increase. Metrics represent what to look out for in assessing the speed at which the global economy is becoming more energy and carbon efficient. We then relate our findings back to the various climate risks.

We expect this type of analysis to be an iterative process since data are likely to be incomplete in the early stages, but should improve over time with more climate disclosure. Examining the resilience of an investment portfolio against the structural shifts that may occur during the transition to a low-carbon economy (such as changing norms to demand for high-carbon goods and services), and adverse climate change impacts as a consequence of warmer temperatures (physical factors such as extreme weather) should grow in importance and foster more climate disclosure.

We believe this framework is equally applicable to individual companies and economies, as well as portfolios. In the next chapter, we provide investor strategies for climate integration.

Investor strategies

- Investors are also being pushed to demonstrate their alignment with advancing a low-carbon transition (rather than hindering it)
- Company winners are those that are good at disclosing a climate strategy as well as the solution providers
- Companies in high-carbon sectors that show preparation for a transition to low-carbon will be better-positioned in our view

Helping, not hindering, a low-carbon world

Investors are not immune from low-carbon scrutiny; asset allocation to take carbon into account

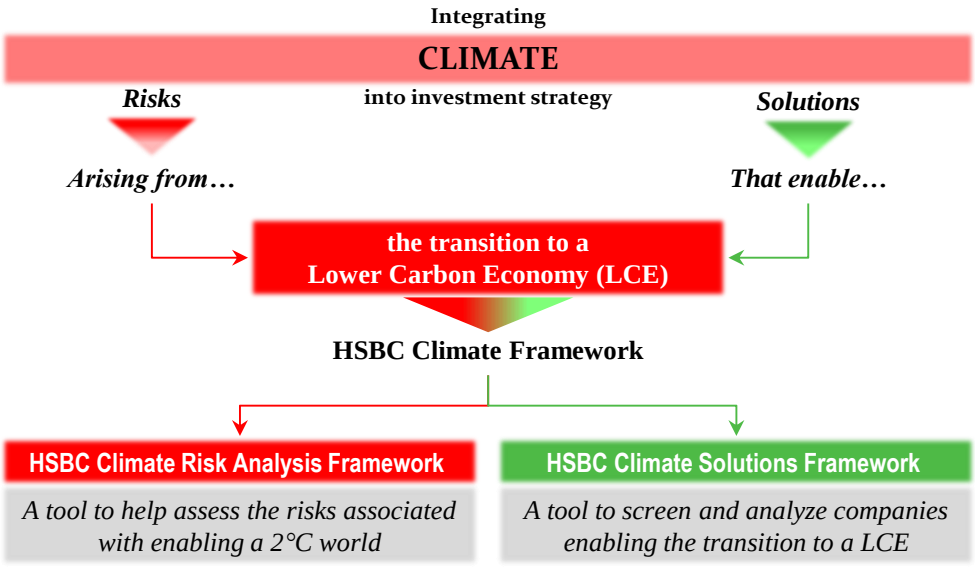
Earlier, we noted that climate change is a disruptive factor for the value and income generating potential of assets, and in previous chapters we focused on using our framework to assess potential climate risks. We expect climate factors to be integrated into financial analysis because we think it is prudent to assess the potential changes to asset values as a result of the low-carbon transition. While this approach captures downside potential, there is also a clear opportunity for investors to align to the likely winners from the transition, and in doing so, help minimise transition risk. In this chapter we map out an investor strategy for integrating climate change. We think this consists of three considerations, which are equally important in our view:

- Assessing the climate risk embedded in portfolio holdings
- Identifying climate solution providers and increasing exposure to them
- Differentiating between companies within sectors to assess the likely winners in the transition to a low-carbon economy

The HSBC Climate Risk Analysis Framework was set out in chapters 2 and 3, and the HSBC Climate Solutions Framework is set out in the sister note to this report, *'HSBC Climate Solutions Framework'*, 12 September 2016 (Please contact your HSBC representative or email Research.Direct@hsbc.com for more information on how to access the full report). The Solutions Framework is designed to filter companies which offer solutions that help to transition towards a low-carbon economy, see figure 6 below.

As well as investment holdings being (passively) affected ***by*** factors related to a warming climate, investment holdings also (actively) contribute ***to*** warming the climate. This is important because it means that investors can be held to account for their own contribution to the climate problem. We expect investors to be pushed to demonstrate how they are allocating capital in a way that is consistent with helping the transition to a 2°C world (versus hindering it). This also means becoming more comfortable with the idea of demonstrating the portfolio impact on the development of a 2°C consistent economy which is why having a robust methodology for differentiating between companies within sectors is becoming more important for investors.

Figure 6: HSBC Climate Frameworks



Source: HSBC

The growing sophistication of climate analysis

Investment decisions by portfolio managers have an impact on the speed of the low-carbon transition

In the past, climate discussion mainly centred on a high-level commentary of which sectors fit into 'high-carbon' and 'low-carbon' buckets. In addition, carbon footprinting (the measurement of how much CO_2 is emitted by the company in the course of day-to-day operations) has been used as a tool to assess company willingness to understand and address operational climate factors. While useful as management quality assessment and as a climate awareness driver, this type of analysis is no longer enough to identify and endorse company differentiation in our view. As investors are put under more pressure to demonstrate their own climate credentials, we expect them to be asked to provide increasingly sophisticated rationale to defend portfolio holding decisions, particularly for energy and industrial sectors.

Consequently, we expect investors to become more demanding with companies on understanding positioning on incorporating climate change issues into business management. In other words, this is an assessment of where companies are positioned along the arrow spectrum that we first presented on page 19 and is repeated below.

Figure 7: Incorporation of climate change issues into business management

Source: HSBC

The idea is that over time companies will provide disclosure that enables investors to better differentiate company peers within sectors. Are they at the operational management end of the scale or are they thinking strategically?

Investor engagement questions

Credibility is becoming a bigger consideration for investors

In many cases, not all the information required to make a sensible judgment on which companies are in a better position for a transition to a low-carbon world is publicly available, which means investor engagement as a means to understanding company climate factors remain important in our view.

We noted on page 9 that investors have become increasingly vocal in high-carbon sectors, and we maintain that disclosure and transparency are becoming more important. However, we think it is worth noting that disclosure and transparency aren't the same thing, because disclosure could be a smoke screen for greenwash. Disclosure merely states that you have a position on an issue e.g. 'the board has a strategy for addressing climate change'. Transparency is revealing what the position is e.g. 'the strategy is to adopt a 2°C aligned transition plan'. Nonetheless, we expect the financial system to be held to greater account on investment decision making and disclosure is a critical part of how the financial system manages this.

While clearly climate change factors are more prevalent in some sectors than others, we think key engagement topics are applicable across sectors. We think the most important engagement topics in relation to differentiating companies are around:

- the carbon intensity of the existing business model in relation to products and services
- the potential for the existing business model to be disrupted by physical factors relating to warmer temperatures
- planning for a 2°C consistent business model
- evidence of enabling a 2°C business model

Is the business model consistent with a 2°C world?

Carbon intensity in relation to products and services

This relates to an assessment of whether or not the existing means of revenue generation at a company is dependent on high or low carbon goods and services. Companies generating revenues from high-carbon activities are obvious contributors to the climate problem, but climate contributors can also be more subtle, such as banks that lend to those industries, or industries which use a lot of energy such as petrochemicals. An assessment of the carbon intensity in relation to products and services enables investors to identify the degree of business model change that could be needed in order to provide sustainable revenue generation in a low-carbon world. The type of questions that capture this are:

- Does the company rely on high carbon assets to generate revenues?
- Does the company rely on high carbon end markets to generate revenues?

The response allows investors to take a view on what it means for the company if the demand for those products and services change in relation to broader efforts to slow global warming.

Disruption potential from physical events

Does the supply chain rely on regions and products exposed to severe weather?

This relates to how resilient the business model is in relation to supply chain or facilities disruption. It means thinking about issues such as how much financial disruption would there be if production facilities cannot operate because of flooding, what would happen if there was a supply chain shortage driven by weather disruption, or whether real estate assets are resilient to sea level rise. The types of questions that capture this are:

- Does the company have geographically diverse operations and how exposed are they to natural weather events such as extreme storms?
- Does the company rely on raw material supply that could be disrupted by changing weather extremes?

The response allows investors to assess the resilience of operations, and hence continuity of revenue generation capacity in the face of weather disruption.

Planning for a 2°C consistent business model

Does the company have a 2°C transition plan?

Even if a company is not operating in a high carbon sector we think it will be subjected to risks or opportunities which are presented elsewhere in the economic system by climate change. Therefore in our view the broader response to climate change is a strategy concern even if the company does not operate in a high carbon sector nor is exposed to physical factors. The types of questions that capture this are:

- Who is responsible for company strategy and planning in relation to climate change?
- What is the strategy?
- Who is accountable for delivery?
- How is delivery of the strategy measured and assessed?

The response allows investors to assess the governance of climate change factors as well as company preparedness for events

Evidence of enabling a 2°C business model

How is the company changing to enable a 2°C consistent business model?

This relates to whether the plans from above are operationally enacted. This is more difficult to assess as it takes time to implement change, but nonetheless we think looking at investment flows of a company can provide an indicator of how climate planning is taken into account. Investing in high carbon goods or infrastructure now could result in write-downs later for instance. The types of questions that capture this are:

- Is capital being invested to produce high carbon goods or services?
- Is capital deployment resilient to climate change risk in the future?
- Is capital being deployed in a way that maximises climate opportunity in the future?

The responses allow investors to judge whether the company is serious about addressing a low carbon future. Investment decisions today on large-scale projects such as energy and transport infrastructure lock-in future levels of carbon emissions for the lifetime of the project, which could have 40-year lifespans or beyond. This can be negative from a climate perspective since it makes it more difficult to help with the future reductions required to be aligned with a 2°C world. We expect investors to be more proactive on scrutinizing future company investment plans and use of capital, in response to their own disclosure requirements of promoting a low-carbon world.

Disclosure requirements

Many of these topics are already covered by initiatives like the CDP, which surveys companies on their climate risks and opportunities. We expect CDP to continue to be critical for continued widespread dissemination of climate related disclosure. We also think that one-on-one investor engagement is currently under way, but that NGO investor activism coalitions will get tougher on raising climate issues, particularly across the financial sector in the next year, and particularly if, as we expect, the Paris Agreement comes into force by early 2017.

The Financial Stability Board task force for climate related financial disclosures was established to make recommendations on what companies should disclose in order for investors to make better judgements on the climate exposure of companies. However, there are many factors that could have an impact on financial stability in relation to climate, such as a rising cost of capital as carbon is re-priced which might mean defaults. Over time, as climate risks become more apparent, companies that are contributing to a high carbon economy could find it harder to attract cheap funding since the risk profile of association with high carbon increases.

Conclusion

We think a robust investor strategy for climate change is threefold. Firstly, assessing the climate risk embedded in portfolio holdings. Secondly, identifying climate solution providers, and thirdly differentiating between companies within sectors to assess the likely winners in the transition to a low-carbon economy.

The HSBC Climate Risk Analysis Framework set out in this report is a comprehensive tool to assess the risks with transitioning to a 2°C world and coping with the consequences of warmer temperatures.

The *'HSBC Climate Solutions Framework'* report of 12 September 2016 (Please contact your HSBC representative or email *Research.Direct@hsbc.com* for more information on how to access the full report) sets out our methodology for identifying and categorising climate solutions providers. In that report we look at the regional exposure of solutions providers.

Within sectors, companies also have different levels of climate exposure, and different levels of 'willingness to adapt'. We think an engagement strategy is important for investors to build a rationale as to why they might want to retain exposure to companies in high carbon sectors. Regulators and civil society are pushing investors, as well as corporates, to provide the groundwork for a low-carbon transition. To that end, we expect investors to be under increasing pressure to provide evidence of facilitating the change. Some of this information is not yet in the public domain, and we think requests for disclosure and transparency on 2°C transition plans will be a key feature of investor engagement on climate to enable a more robust risk assessment of portfolio holdings.

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Disclosure appendix

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