Absolute Thematics

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Stranded Assets: A New Concept but a Critical Risk

Fund managers are inherently concerned with risk. This note explores the relatively new concept of Stranded Assets and seeks to show how they are already a critical 'hidden' risk in almost every Global Multi-Asset and Equity portfolio and how they will become increasingly important to all asset managers in the coming decade.

"Stranded Assets" are a relatively new concept (coming from the Economic Geography literature) and are defined as those physical assets which lose their economic value well ahead of their anticipated useful life. The academic literature highlights how environmental change is making investments over a wide range of sectors and asset classes at risk from being 'stranded'.

Investments which depend on the natural environment, particularly those exposed to water, fossil fuels and agriculture, are increasingly at risk from such significant premature write-downs as regulation tightens, natural capital is impaired, clean technologies develop and socio-political pressures increase.

Water, energy and food systems are tightly linked. Water is needed to extract fossil fuels and generate power; energy is needed to treat and transport water; and both water and energy are needed to grow food. This energy-water-food 'stress nexus' will increasingly force corporates and asset managers to identify the implicit risks in their existing and planned investments.

Asset Stranding is already creating costs for corporates and reshaping Global Portfolios. Since 2011 Global corporates are estimated to have spent more than $84bn on improving water management systems as climate change and rising demand has increased water scarcity. European gas-fired power stations are already being closed prematurely, costing nearly €6bn in 2013 as the energy landscape shifts. Weather-related losses have increased four-fold since the 1980s to $200bn over the past 10 years. Water scarcity could cut China's food production by up to 23% by 2050 vs 2000, and could put almost half of the world's GDP ($63trn) at risk if companies persist with 'business as usual'.

Energy companies 'invested' $674bn in new coal and gas projects last year, when there is a $28 trillion 'Carbon Bubble' of identified oil reserves which will be UNUSED if already agreed climate change targets are to be met. The shifts are already happening. Globally, half of new electricity generation in 2012 was renewables, while some asset managers are divesting carbon assets.

The scale of stranded assets will increase dramatically in the coming decades. Coal, oil and gas, along with mining and agricultural sectors are most likely to be negatively affected (US Coal sector capitalization has fallen by almost 20% since the Obama/EPA announcement in June 2014). Countries reliant on such sectors may also see their sovereign bond ratings suffer. Developed markets will be impacted by the pressure on Financials, especially Insurance, while Emerging Markets could suffer as the volatility of food prices increases.

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Stranded Assets are those physical assets that lose their economic value prematurely (due to environmental shocks)

'Stranded Assets' is a relatively new concept helping investors recognize the tangible risks that environmental change may bring to their portfolios, now and in the future. Assets stranding occurs when physical assets lose their economic value well ahead of their anticipated useful life. We show how a wide range of assets are potentially at risk due to direct climate risk, regulatory change, technological innovation and socio-political pressures (Figure 1).

Investments may become unprofitable as the physical and regulatory environment changes

This is not an issue for the future. Climate risk is already having a significant and irrevocable impact on our environment and has been identified as a serious global threat by both Academics and Governments, with impacts on the asset base already apparent, with weather related insurance losses of $200bn in the last 10 years.

Climate changes will dramatically alter our ability to carry out business-as-usual

Our economic growth and current lifestyles are inextricably linked to the emission of pollutants. However, if we fail to make significant changes, climate change has the capacity to dramatically alter our ability to maintain 'business-as-usual', with 52% of the world's population suffering 'water stress' by 2050 if there is no change. Yet Corporates often appear to assume a stable environment when looking to site their production facilities or source their inputs. However, climate change is already causing crop-growing regions to shift, tourist attractions such as coral reefs to be degraded, cities and manufacturing plants to be flooded. Adaptation is coming at a high cost to companies, governments and insurers.

The Water-Energy - Food stress nexus will be critical in shaping the risk of Asset Stranding

Food, water and energy systems are all interconnected and interdependent – the 'stress nexus' as Shell refer to it. Each will separately come under increasing pressure in the coming decades, with each representing significant potential asset stranding. Global companies have spent more than $84bn since 2011 worldwide to improve the way they conserve, manage or obtain water. However, water conservation will not be enough to prevent asset stranding, the responses will need to be multidisciplinary and multisectoral.

Fossil fuel companies hold at least three times more proven reserves of oil, gas and coal than can be safely burned

A key source of asset stranding will likely be Fossil Fuels. Globally, fossil fuel companies hold at least three times more proven reserves of oil, gas and coal than can be burned if we are to achieve the internationally agreed goal of limiting global warming to below 2°C. Despite this 'carbon bubble' (worth $28trn), companies invested $674billion last year developing new projects, while Governments provided $523bn of direct fuel subsidies. Current reserves and future assets will, likely, either be stranded, or lead to irreparable climate damage threatening widespread asset stranding.

Asset Stranding will be concentrated regionally in islands or low lying coastal areas, while assets in Canada, Northern Europe and Russia might be re-rated

We believe such risks (and opportunities resulting from technological innovation and shifting competitive advantages) will impact many different asset classes; including equities, government bonds (and their sovereign credit ratings) and agricultural commodities. Many regions, and their companies and residents, will be significantly impaired by climate change, particularly in low-lying areas in the world, such as island nations, coastal areas and flood plains. Higher temperatures in the southern USA, Mediterranean, the Middle East and sub-Saharan Africa could reduce productivity, whilst benefitting Canada, Northern Europe and Russia.

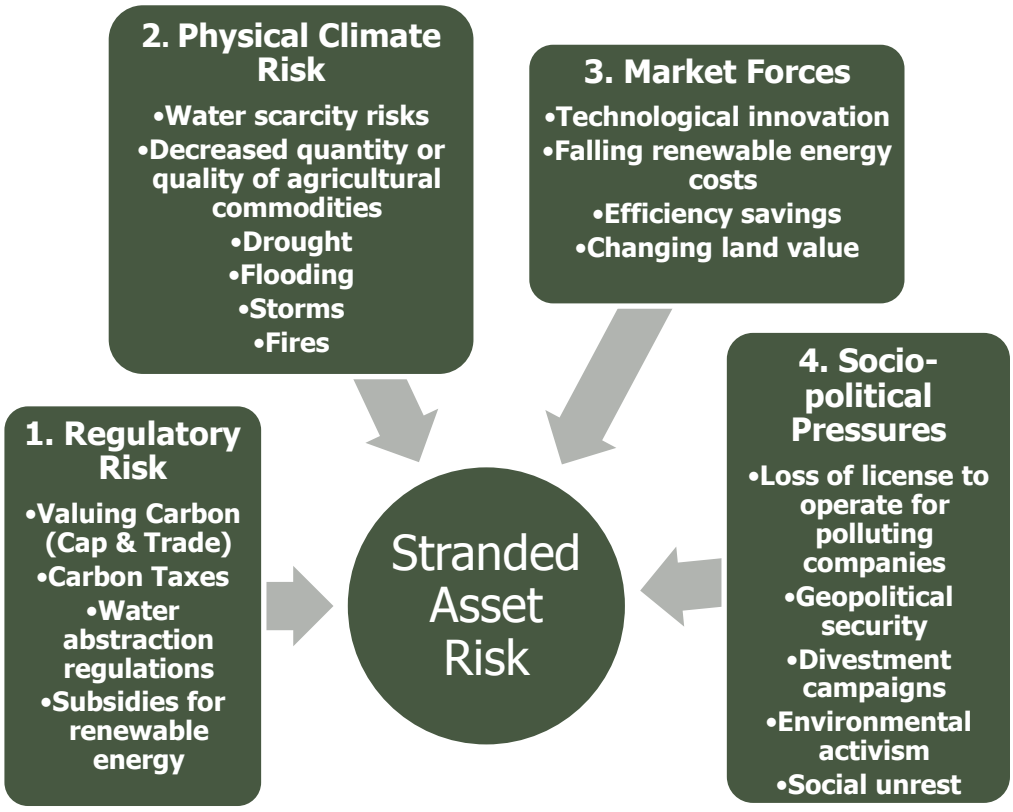
Non-renewable energy, mining, utilities, agriculture and transportation sectors are at risk…but so are financial services

Industries identified as at greatest risk from stranded carbon assets include non-renewable energy, mining, utilities, and transportation. However, assets in cleaner industries may also be at risk under current and future climate change such as agriculture and consumer goods industries rely on complex, often carbon-intense, supply chains and underlying natural capital for their products. These sectors are also particularly vulnerable to changing consumer preferences for 'green' and 'local' products. Clearly the Financial Sector is also at risk from insurance losses which have increased four-fold since 1980 and from declining investment returns under asset stranding scenarios.

The concept of Stranded Assets should help asset managers better understand climate risks inherent in their portfolios

The concept of Stranded Assets should help asset managers have a more tangible understanding of how climate change may impact their portfolios in terms of both avoiding additional uncompensated risks whilst taking advantage of mispricing opportunities.

Figure 1: Contributors to Stranded Asset Risk



Source: ASR Ltd.

What are 'Stranded Assets'?

Stranded Assets are Assets that have suffered a premature reduction in their economic life

A recent definition, provided by Oxford University's Smith School for Enterprise and the Environment (SSEE) defines 'stranded assets' as "assets that have suffered from unanticipated or premature write-downs, devaluations or conversion to liabilities".

This can be caused by a range of environment-related risks and these risks are poorly understood and regularly mispriced. This has resulted in a significant over-exposure to environmentally unsustainable assets throughout our financial and economic systems. Current and emerging risks related to the environment represent a major discontinuity, able to profoundly alter asset values across a wide range of sectors. Some of these risks include:

More frequent and severe climate events could reduce the profitability and viability of investments

- Environmental challenges (e.g. climate change, water constraints)
- Changing resource landscapes (e.g. shale gas, phosphate)
- New government regulations (e.g. carbon pricing, air pollution regulation)
- Falling clean technology costs (e.g. solar PV, onshore wind)
- Evolving social norms (e.g. fossil fuel divestment campaign) and consumer behaviour (e.g. certification schemes)
- Litigation and changing statutory interpretations (e.g. changes in the application of existing laws and legislation)

A simple summary of the concept is shown below, where the interaction of the risks, the drivers and the adaptability are all multiplicative factors in the eventual financial risk imposed.

Financial risk of asset stranding =
Intensity of stranding driver x Exposure to risk x Vulnerability Sensitivity Adaptability

The clearest example of stranded assets is found in the fossil fuel space

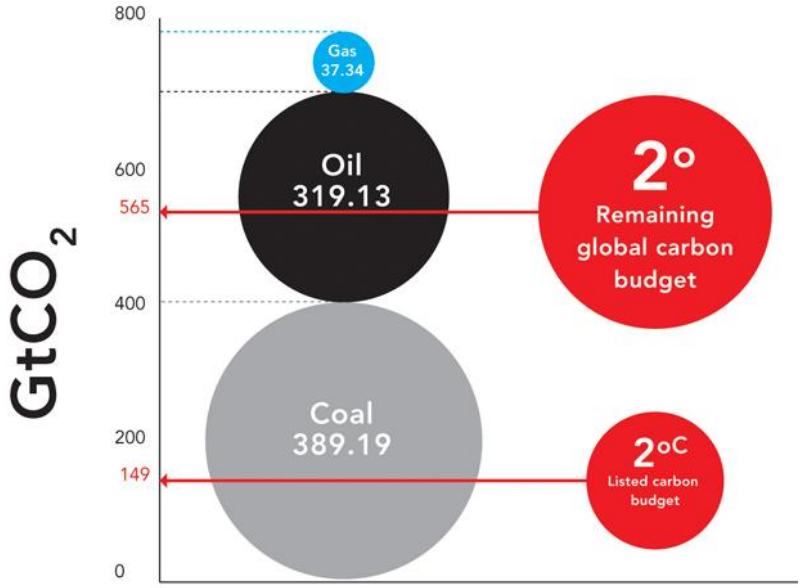
Stranded Assets and the "Carbon Bubble"

Much of the research into asset stranding has emerged from the field of Economic Geography as researchers have sought to assess the impact of a 'carbon bubble'. This is one scenario which could cause widespread investment write-downs, as current and future reserves of oil and gas are labelled 'unburnable'. It provides an excellent introduction to the Stranded Asset concept.

The Carbon Bubble relates to the 80% of identified reserves that cannot be burnt if internationally agreed climate change targets are to be met

The Carbon Bubble relates to the idea that in order to avoid the worst scenarios of climate change, the IEA forecasts that more than two-thirds of today's proven fossil fuel reserves cannot be used before 2050. Even this would only provide a 50% chance of limiting warming to 2°C (the international climate target agreed at Copenhagen in 2009). To stay under 2°C, companies could only burn 149 GtCO2 of listed carbon reserves, compared to existing stock of 745 GtCO2, suggesting that 80% of these assets should be stranded if we want to avoid the worst effects of climate change (Figure 2).

Figure 2: Map of Carbon Bubble – Emissions potential of listed fossil fuel reserves vs. remaining carbon budget



Source: Carbon Tracker Initiative (2012)

Figure 2 shows the amount of fossil fuels that have been 'listed' (which excludes those owned by Sovereign 'unlisted' entities and are believed to be almost as much again)…

…if we are to stay within the 2 degree target for climate change, then only 565 Gt of CO2 can be burned before 2050…

…However, taking the current proportions of listed and unlisted assets this would mean that just 149 Gt of 'listed' CO2 assets are likely to ever be used…

….everything else will likely be stranded!

The implications of this finding are very profound for asset managers. If we are looking at a situation where potentially 80% of the fossil fuel reserves of listed Energy companies are potentially going to be 'Stranded' then they are significantly over-valued.

The second point is that asset managers should be more questioning about further investment in searching for new reserves. Yet, despite this, leading fossil fuel companies spent $674billion last year to find and develop new potentially stranded assets!

If policy makers and businesspeople are serious about limiting the worst effects of climate change the price of carbon should better incorporate the associated negative externalities and the likelihood of future caps on carbon emissions reducing the potential economic viability of some of these reserves.

The Carbon Bubble could result in $28tn losses for fossil-fuel companies over the next 20 years

The net effect of all these factors is that investments in current and future reserves are thus highly likely to become 'stranded' in some way, with academic estimates suggesting that fossil fuel companies could stand to lose $28 trillion gross revenues over the next two decades.

The problem for investors is that the interlinkages in the Global Economy mean that 'direct' effects from Global Warming are not the only sources of Asset Stranding. In the following section we look at a range of potential causes that could prematurely undermine the current and future value of many 'listed' physical assets – well beyond those in the Energy Sector.

Causes of Stranded Assets

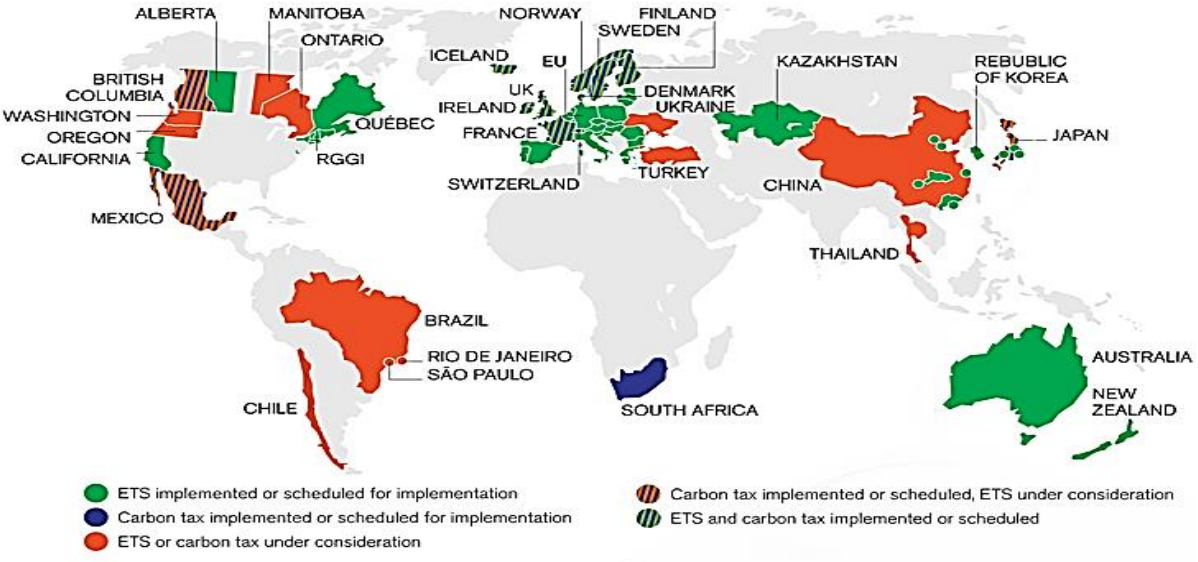
- **Regulatory pressures will force future emissions reductions and efficiency measures**
- **Agricultural degradation and water-shortages will affect global supply chains**
- **Markets will have to adapt to new technologies and a lower-carbon economy**

Regulatory Risk:

39 national and 23 sub-national jurisdictions have implemented or are scheduled to implement carbon pricing instruments

We expect political bodies will increasingly engage with the issue of climate change; we will see a convergence between mere discourse and action as climate changes have progressively more tangible impacts around the world. A recent World Bank report found that 39 national and 23 sub-national jurisdictions – responsible for almost a quarter of the global greenhouse gas emissions – have implemented or are scheduled to implement carbon pricing instruments. Figure 3 shows how these initiatives are widespread on a regional basis, rather than being located mainly in just one area. Although international agreements may remain elusive, increasingly national and city-level regulations are having a direct impact on various sectors, such as energy production, transport and utilities. In addition to carbon regulation, policies focused on a variety of goals could also cause asset stranding. These could be wide-ranging, but might include water efficiency regulation or pollution reductions aimed at reducing health externalities.

Figure 3: Map of Carbon Pricing Regulation



Source: World Bank (2014)

Physical Climate Risk

Storms, flooding, drought, changing temperature and precipitation patterns globally have the power to disrupt or destroy industry and agricultural assets; the consequences of physical event-risk are far-reaching across the global economy. This is particularly likely due to the integration of global supply chains increasingly exposing Western companies to global, rather than local, climatic trends.

42 million people in Asia were displaced by "extreme" weather in 2010-11

As climate change intensifies it affects an increasing number of consumer and producers. Areas become uninhabitable and/or unproductive, significantly affecting consumer demand within these regions, as well as productivity trends as labour pools shift. These trends are evident already with 42 million people in Asia displaced by "extreme" weather in 2010-11, according to the Asian Development Bank (ADB). Climate based migration and refugees will likely further rise in coming decades.

Despite the already apparent trends in extreme weather, trillions of dollars have been invested in infrastructure, real estate and industry located around coastlines and on floodplains. These assets are increasingly exposed to storm surges and long-term sea-level rise. More frequent extreme weather events can also exacerbate coastal erosion. Bangladesh has become the 'new China' in manufacturing output, especially for the garment industry, yet the majority of the country is less than 5m above sea-level. Flooding from major rivers can inundate up to 60% of the country at one time. Such countries are particularly vulnerable to climate change and in consequence, so are global supply chains which depend on their output. The credit crunch shows that systemic risk is triggered by the weakest, not largest, link.

Nature-driven tourism, such as ski-resorts or coral reefs, may be irreversibly affected by climate change

Natural capital, the regenerative assets of the environment, will be deeply affected by climate change. According to UNEP, a 10% reduction in the productive capacity of natural capital, could lead to a reduction of 1-4% of a nation's GDP. Countries dependent on nature-driven tourism (e.g. ski-resorts or coral reefs) may particularly suffer as service infrastructure relating to these industries becomes stranded.

Agricultural degradation and water shortages are likely to be leading causes of asset stranding

Agricultural degradation and water shortages are of particular concern to scientists and policy-makers alike. If agricultural production is forced to shift geographic regions due to falling yields in current breadbaskets, the infrastructure and human capital supporting this industry is likely to become stranded. Rising temperatures, changing seasons and extreme weather are all likely to affect food production in coming years.

US$63 trillion – 45% of projected global GDP – could be at risk from water scarcity by 2050

Furthermore, water scarcity will significantly affect the way business is conducted and where it is located, potentially stranding various investments reliant on reliable and clean water sources. "Business as usual" water management practices will put approximately US$63 trillion – 45% of projected global GDP – at risk in 2050 (according to a 2011 study by Veolia Water and IFPRI. Less predictable rainfall, more frequent droughts and reduced snowfall are all likely to contribute to asset stranding as a result of climate change.

Market Forces

Half of new electricity generation added worldwide in 2012 was renewable

Renewable energy technologies are becoming increasingly economically competitive as costs continue to fall, and pressures rise on carbon-intensive production. A range of renewable energy options, including hydro-power, geothermal, wind and photovoltaic electricity generation are reaching cost-competitiveness in a number of markets globally. A 2013 report on the renewables sector showed that half of new electricity generation added worldwide in 2012 was renewable, accounting for 70% in the EU and 50% in the US. In the same year 4.1% of UK energy consumption was accounted for by renewables. Such trends are likely to have a dramatic impact on the global energy map, with one of the key features of the changing landscape being the diversified and distributed nature of renewable energy.

Distributed Energy is likely to increase in the coming decade, putting traditional 'grid' infrastructure at risk of stranding

Companies such as Apple and Walmart are already investing heavily in renewable energy, seeing such investments as offering them long-term energy price stability and security, putting further pressure on 'traditional' energy producers and risking stranding some of their 'grid' infrastructure assets. The distributed energy phenomenon is likely to continue and grow in the coming years, as both the economic, political and environmental case for renewable energy continues and technologies advance further, changing our energy landscapes away from more volatile and polluting fossil-fuel production.

Developing nations have the chance to 'leapfrog' past traditional carbon-intensive energy grids

Such a shift is particularly likely in the developing world which lacks such an established non-renewable energy infrastructure network, with renewable technologies able to 'leapfrog' fossil fuel production to offer secure and affordable electricity. Developed world governments may also be keen to distribute energy production similarly in an attempt to reduce dependence on unstable energy exporting regions such as Egypt, Syria and Iraq.

Sociopolitical Risks

Carbon-intensive businesses could lose their license to operate

In the absence of widespread regulation, and as the impacts of climate change become more visible, socio-political pressures could create an environment where carbon-intensive businesses could lose their license to operate. While the worst impacts of carbon emissions may take longer to unfold, the upsurge in recent years of climate-related extreme weather events have begun to have a significant impact on public perceptions of greenhouse gas pollution.

Public anger at pollution-related health issues is growing

Public disapproval of traditional energy production is becoming more salient, with campaigns against costly environmental and social externalities gaining media and political coverage. Such efforts, along with high profile events such as the BP Oil Spill and Fukushima tsunami, have the potential to become long-term obstacles to carbon-intensive industries. This kind of socio-political pressure has, for example, led to nuclear-power losing its license to operate in Germany and Japan, leading to widespread asset stranding. Coca-Cola recently lost its license to operate in an Indian state due to local protests at their extraction and pollution of scarce water resources.

7 million people died from air pollution in 2012

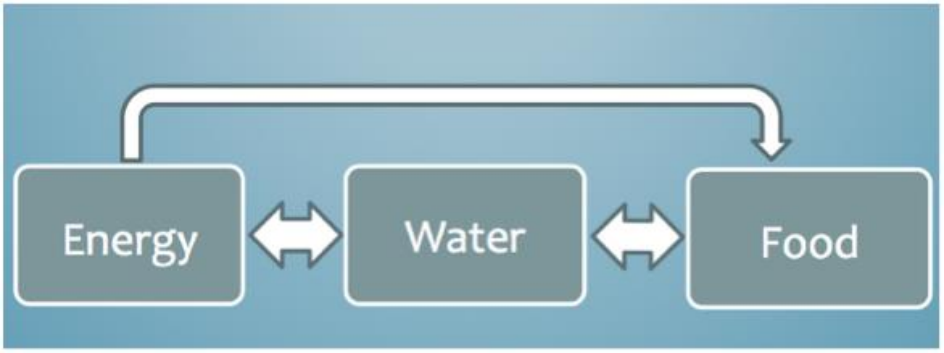
Social pressure is likely to increase in the future as the health costs of pollution continue to rise. According to a WHO report, around seven million people died from the effects of air pollution in 2012 — over a third of them in China, India and other fast-growing nations in Asia. In the EU, approximately 22,000 deaths were attributable to pollution from coal-fired power plants in 2010. Air pollution in many global cities is now so bad that politicians are forcing polluting industries to close temporarily in order to reduce smog conditions. With the rise of social media, corporate reporting and internet technologies, companies are increasingly accountable for the impact they are having, with the US Embassy in Beijing reporting the air quality in the city online, and showing that pollution can reach more than 20 times safe levels. China has already seen multiple municipal-level protests at the levels of pollution and this could speed up regulatory changes.

Physical Stranded Assets

Water, Energy and Food are all intimately linked and will form a "stress-nexus" that will be a major source of Asset Stranding in coming years

- **Water-energy-food nexus will form the crux of stranded assets**
- **Half the global population will live in severely water-stressed regions by 2025**
- **Fossil-fuel stranding could alter the energy landscape**

This section uses the stress-nexus of water-energy-food to explore some likely impacts of environmental change in stranding assets.



Water Scarcity

Half of the global population will live in conditions of severe water stress by 2025

Water-scarcity is a key factor which could leave assets stranded. Droughts are blighting productivity and access to water across the globe, from Ecuador to Australia. California is currently in the midst of a severe drought, leaving households and landowners without water. The FAO believe the demand for water will increase by around 50 percent in the next 30 years and that around 4 billion people, one half of the world's population, will face conditions of severe water stress by 2025.

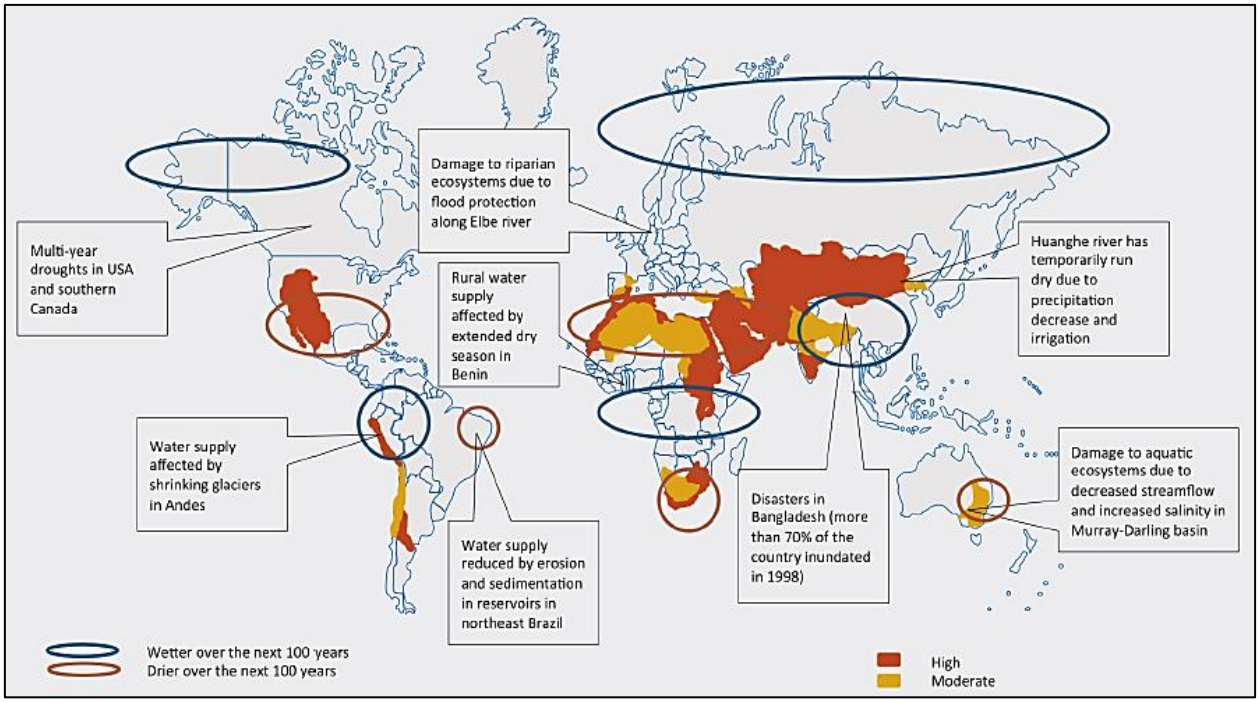
85% of China's power-generation capacity is in the water-stressed north of the country

The era of water abundance in China is over, and competition for resource access between industry, agriculture and urban centers is starting to bite. According to Bloomberg New Energy Finance, 85% of China's power-generation capacity is in the water-stressed north of the country. In December 2013, the Eastern route of the South-to-North

Water Diversion Project began pumping water from the southern Yangtze River northwards in an attempt to balance out the availability of water in the country. However, costs of the South-North Project have already far outstripped initial estimates, reaching $79.4 billion by 2014, with the third branch of the project yet to begin construction.

With political efforts struggling to combat the scale of the crisis in sustainable ways, and with social unrest growing as the pollution of existing freshwater supplies increases, the chance of infrastructure and cities having to ration water is high. The question then remains as to how governments decide to prioritize, and what is left stranded.

Figure 4: Map of Stranded Asset Risk from Water Scarcity



Source: Caldecott et al. (2013b)

The Southern USA, Med and Middle East face major risk of water scarcity

As the climate changes, many regions will become water scarce (See Figure 4), with a 2013 report published in Nature finding the Southern USA, the Mediterranean and the Middle East at most risk.

Even areas forecast to receive more rain, such as India and Bangladesh, are at risk from extreme rainfall resulting in flooding.

Even areas with water may suffer from flooding such as India and Bangladesh

Industry, particularly agribusiness, energy production and mining are heavily dependent on constant water supplies. Without access to reliable water supplies, factories and power plants, agricultural land and indeed entire cities could become stranded.

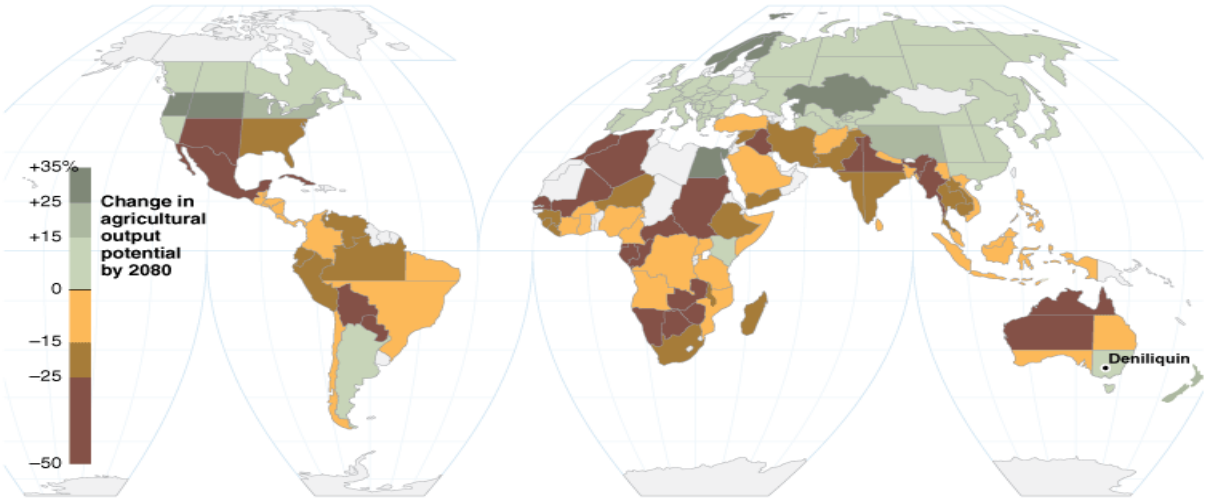
Agricultural Stranding

Water scarcity could threaten agricultural irrigation systems, reducing yields and potentially stranding areas of land

17-55% more freshwater than is currently available will be needed by 2025

Inherently linked to issues of water scarcity is the likelihood of agricultural stranding. Irrigated agriculture is particularly sensitive to small temperature variations and extreme weather events, and already acts as the main water use sector in many countries around the world. According to the FAO, even if efficiency is improved, 17% more freshwater than is currently available will be needed by 2025 to produce sufficient food for the growing population. This could rise to 55% more if efficiency gains are not realized. With demand growing from other uses as temperatures increase and population rises, water quality and quantity could decline, with producers struggling to attain sustainable yields, potentially stranding assets as areas become unsuitable for production (Figure 5). Hannah (2013) suggests "…anywhere between 19 percent and 73 percent of the land currently suitable for grape- growing in major wine regions will no longer be appropriate for viticulture by 2050." There will be fixed assets lost in stranded infrastructure, but also in stranded human capital, with know-how and expertise in one region also potentially stranded as production shifts and new training is required. However, Figure 5 shows that some regions will become more suitable for agriculture, representing opportunities for investment, particularly in Northern territories.

Figure 5: Farming in a Warmer World



Source: Cline (2007)

China's total food production could decline by 14% to 23% in 2050 compared with 2000

Almost 25% of the world's rice production could be at risk by 2050

The OECD-FAO has forecast that as a result of climate changes, China's total food production could decline by 14% to 23% in 2050 compared with 2000. By the end of the century, US corn, soybean and cotton yields are predicted to be reduced by 63% - 82%. A 2013 report by the SSEE, exploring the risk of agricultural stranded assets, suggested that water-scarcity might impact almost 25% of the 162 million hectares of land used for rice production in 2012 by 2050 (15-20 million hectares of irrigated rice will experience some water scarcity, while 23 million hectares will be affected by drought). Rice is thus particularly vulnerable as was made evident in the 2008 global rice crisis sparked by adverse weather events, following 6 years of drought in Australian rice-growing regions and political restrictions on rice imports and exports. These impacts are likely to affect food prices in the coming years.

Fossil Fuel Stranding

Coal powered fire stations are assets at risk of stranding

Several key pieces of research, including by the SSEE and S & P, argue that asset stranding may occur for coal-fired power stations as climate regulations are introduced and renewable energy becomes a more socially and financially acceptable alternative.

China spent $56.3bn on renewables in 2013

While most predict continued strong demand for coal, China is already seeing strong shifts including "a serious concern over air pollution, a desire to reduce greenhouse gas emissions and to reduce exposure to volatile international commodity markets, particularly in oil and gas". As a result, there has been a huge investment in and deployment of non-fossil energy driven largely by new policy frameworks, the emergence of carbon pricing and falling technology costs. According the Renewable Energy Policy Network, China led the rest of the world in renewable energy investment in 2013, spending a total of $56.3 billion on wind, solar and other renewable projects.

Any transition to a low-carbon economy will necessarily cause significant stranding in the energy sector

As climate change becomes more visible, international pressure to reduce our dependence on fossil fuels (political, financial and social) is likely to increase. Renewable energy production is likely to increase dramatically, presenting a long-term investment opportunity.

Coal accounts for 16% of Australian exports and 3.4% of GDP. Reduced coal demand from China will put Australian mining assets at risk of being 'stranded'

Water scarcity could also adversely impact coal demand, while shale gas and changing international gas markets will result in more coal to gas switching. These factors are all likely to reduce China's growth in coal imports below levels currently expected, (which would have implication for the stranding of key Australian mining assets - coal exports accounted for AU$38.9 billion in 2012-2013; equivalent to 3.4% of GDP and 16% of total export values), and are likely to be replicated elsewhere globally.

Even in the last few weeks new government regulations in the US threatens to close hundreds of coal-power stations by demanding reductions in emissions by 30% by 2030. Demand below expectations, and lower coal prices as a result, would increase the risk that coalmines, reserves and coal-related infrastructure (such as railways) could become stranded as they are mothballed or abandoned.

Globally there were $523 billion in direct subsidies for fossil fuels in 2011

According to IMF, governments around the world gave $523 billion direct subsidies for fossil fuels in 2011. If a Carbon Tax of $25 per ton of CO_2 is included the subsidies total $1.9 trillion. Removing fossil fuels subsidies and introducing carbon taxes would further reduce their consumption and make the alternative energies even more competitive, but could have the potential impact of large amounts of assets globally. This could coincide with oil reserves being depleted and the bursting of the 'carbon bubble' whereby future reserves must remain in the ground in order to limit the worst impacts of future climate change.

Since more than 80% of global energy consumption is based on fossil fuels, and the energy industry accounts for two-thirds of global GHG emissions, any transition to a low-carbon economy will necessarily cause significant stranding in the energy sector.

Utilities Stranding

While much has been discussed as to the potential for stranded fossil-fuel assets, other utilities and energy companies are also at risk.

Nearly €6bn losses can be attributed to write-downs on gas-fired power investments in 2013

The Smith School highlights one of the clearest cases of asset stranding in recent years being the example of high-efficiency German and Dutch gas-fired power stations being rendered uneconomic, worth nearly €6bn in losses, due to depressed energy prices, reduced electricity demand following the global financial crisis, growth in renewable energy and cheap US coal imports.

Renewable energy could supply 80% of US electricity in 2050

The National Renewable Energy Laboratory estimates that using renewable electricity generation from technologies that are commercially available today, in combination with a more flexible electric system, is more than adequate to supply 80% of total US electricity generation in 2050.

However, even renewables are at risk from stranding, with solar farms in Spain unstuck by unanticipated subsidy reforms and nuclear power plants in Germany and Japan mothballed due to political concerns following the disaster at Fukushima and strong anti-nuclear lobbying.

Investment Impact of Stranding

Investors will increasingly confront the impact of Asset Stranding in their portfolios, both in Equity portfolios and, potentially Bond portfolios

- **Equities and sovereign bonds exposed to stranding risk are likely to be devalued as investments fail to return predicted profits**
- **Insurers will be affected by increasing climate-related risk**
- **Investment opportunities exist in the shift towards a low-carbon economies**

The stranding of assets around the world are likely to have multiple and interlinked impacts on our global economy and everyday prices.

Equities

An immediate Equity market response to Stranded Assets is likely to be limited…

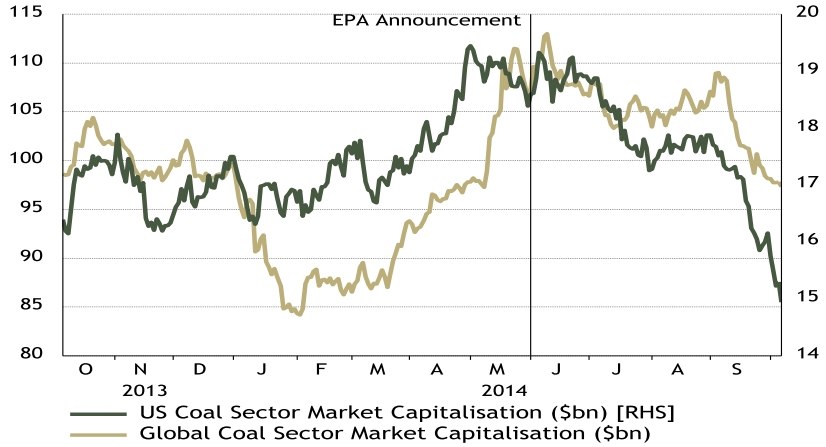
Immediate market reaction to the identification of asset stranding risks will probably be limited. However, as the impact on individual supply chains becomes more evident and the risk of asset stranding becomes a much greater underlying focus of corporates, the greater the risk that medium and long-term valuations and profits will be challenged.

…with investors looking for 'hard' evidence

The Obama/EPA coal legislation is, potentially, a warning of things to come!

The problem for equity investors is that change, particularly the regulator change, is likely to be abrupt and non-linear. This was evident in the response to the 'surprise' Obama environmental legislation. The Global coal sector lost almost $10bn of market value in the following month, while the market capitalization of the US Coal sector has fallen by almost 20% (from $18bn in early June 2014 to $15bn by early October 2014) as investors seek to diversify or divest from such assets.

Figure 6: Obama/EPA impact on Global and US Coal Sectors



Source: ASR Ltd. / Thomson Reuters Datastream

The Obama / EPA announcement to reduce coal pollution by 30% of 2005 levels by 2030 has helped cut 20% from the market value of the quoted US Coal sector

As this report shows, the likely areas for Asset Stranding are relatively apparent suggesting that investors should consider acting ahead of, rather than responding to, policy changes or potential extreme events.

Asset stranding in the transportation sector is likely, and could have widespread repercussions throughout supply chains

The transportation sector, particularly autos and aircraft remain highly exposed to carbon prices. In recent years US and European aircraft manufacturing sectors have benefitted from airlines buying new, more fuel efficient, fleets. However, future changes in regulation could severely hamper airline profitability (as was shown by the reaction to the EU proposal to impose a carbon tax on aviation fuel). Changes in regulations or social licenses could have a significant negative impact on equity markets more generally given that global supply chains remain dependent on fast and affordable distribution networks. As polluting companies lose their licenses to operate, investments in more efficient, cleaner and diversified assets are likely to be safer in the medium to long-term.

The viability of high capital expenditures in the future by fossil fuel companies in particular need to be better evaluated against the risk of the carbon bubble which is likely to greatly reduce the expected return from these investments. Oil companies will have to spend more to produce less and investors have already begun to ask companies to better evaluate climate risks and return more capital to shareholders.

Shadow carbon prices are being used by some companies to evaluate likely future returns

Carbon prices are already established in several major markets, but are likely to become more prevalent in years to come. In some cases, companies, recognizing the risk of future carbon prices, implement shadow prices to better establish future returns on new projects. Research done by CDP found that many companies are already using prices ranging from US $6-60 per metric ton of CO_2e, with leading oil companies adopting the higher-end prices so that they don't undertake projects that are too close to the margin of future profitability. For example, ExxonMobil is assuming a cost of $60 per metric ton by 2030. BP and Royal Dutch Shell both use $40 per metric ton.

Utilities companies are also at risk from the increased cost of accessing scarcer water, as well as the challenge of adapting to the growth of

distributed energy. Electricity generation companies could increasingly find that their traditional 'grid' infrastructure is at risk of 'stranding' as investment in 'smart grid' technologies accelerates.

Substitution effects are likely to increase as new technologies develop and the climate changes

Regulatory changes may well be more likely to affect long-term valuations of big-cap equities than extreme weather events, with many having the adaptive capacities to move production elsewhere in the event of a localized disaster such as drought or flooding. However, whole regions or even countries being affected could cause significant loss of fixed assets along supply chains, especially in developed economies where the value of assets held tends to be greater. This was experienced during a 6 year drought in Australia, closing down rice production in the South-West. As reliance on rice failed, vineyards were established where rice paddies had once been, and this ability to adapt to climate shifts and find substitute crops has allowed those farmers to profit from this opportunity, as grapes are a profitable crop, yielding a pre-tax profit in 2008 of close to $1,680 an acre compared with $240 for rice and are also much more water-efficient. Greater uncertainty about agricultural prices could also negatively impact Emerging markets more generally, since they tend to have a higher share of foodstuffs in the consumption basket – making them more sensitive to food prices,

It is likely that the next decade will see a switch towards both physical and equity investment in low-carbon economies

Investing in equities likely to benefit in low-carbon economy and away from climate-sensitive equities could reduce risk. Renewable-energy based technology, climate-proof crops and infrastructure should benefit.

Sovereign Bonds

Traditional sovereign credit risk analysis appears to inadequately reflect stranded asset risk

Sovereign bonds are typically considered reliable, low-risk assets. However, a 2012 UN report on environmental risk highlights that "Traditional sovereign credit risk analysis appears to inadequately reflect pressures from increasing global natural resource scarcity, environmental degradation and vulnerability to climate change impacts".

Generally, it is the poorest countries that have the greatest vulnerability to climate change…

A sovereign that relies on the export of particular goods - especially fossil-fuels, natural capital (e.g. nature tourism) or agricultural goods - may see sudden reductions in both quality and quantity of yield on account of climate change; resulting in unexpected adjustments to credit-ratings. For example, the core competencies of agriculture-based economies may become eroded and capital expenditure wasted, while production becomes increasingly idle and displaced across borders. Those countries with the capital able to develop substitute crops, as Australia did with vineyards in formerly rice-growing regions, may limit the impact of asset stranding on their credit rating and export revenues, but others, particularly developing and oil producing countries are likely to be adversely affected.

…and are at greatest risk of their credit ratings being challenged if their economic infrastructure becomes stranded

There appears to be an inverse correlation between country wealth and vulnerability to climate change due to dependence on natural capital incomes. As such, countries with lower credit ratings may be at greater risk from asset stranding. Richer, fossil-fuel exporting countries, might also founder, if unwilling or unable to adapt to a low-carbon world as large portions of their economic infrastructure may become stranded by stricter regulations and a changing Global energy landscape.

The Insurance Industry and Real Estate

Many of the world's great cities are coastal and are often key supply chain hubs

Many of the most populated cities in the world and real estate assets are coastal trading hubs, vital in global supply chains. Many of these are exposed to flooding and storms. UN estimates suggest that exposure of economic assets to extreme weather events is expected to increase between 2005 and 2070 from $416bn to $3,513bn in Miami, $8bn to $544bn in Dhaka and $84bn to $3,557bn in Guangzhou. While not all of this value may be stranded directly, without sufficient insurance, damages may reach a point where stranding occurs due to repair costs.

Climate change has already caused $200bn of weather related insurance losses in the last 10 years

Lloyd's of London has already called for better incorporation of climate change into insurance models as weather-related losses around the world have increased from $50bn in the 1980's to close to $200bn over the last 10 years as a result of climate change, population growth, development and the concentration of fixed assets in at-risk locations. A recent report by the Generation Foundation also found that the cost of US Federal crop insurance has exploded in the past two years, largely because of climate-related extreme weather events. While no single event can be attributed to climate change, scientists are confident that such events will increase in frequency and intensity.

The OECD/World Bank estimate that coastal cities will face direct costs of $52bn a year from flooding by 2050…

….and up to $1trn a year if storm surges, sea levels rise and sinking land are included!

In a 2013 report, the OECD/World Bank suggested that without adequate adaptive measures, large coastal cities could face global flood costs of $52bn a year by 2050 (see Figure 6), up from $6bn in 2005 (assuming just population growth and socio-political factors). This increased to $1trillion a year in damages if sea-levels rise, storm surges, sinking land, and global flood damage was included. Hurricane Sandy caused damage estimated at $19bn in New York (and $50bn in total). Mr. Bloomberg, then Mayor of New York, responded by proposing a $20bn climate risk adaptation project stating, "if a similar storm were to strike three decades from now, the cost could be $90 billion". While coastal real estate is most often associated with climate related asset stranding inland real estate is at risk from rising temperatures, river-flooding and water scarcity.

Figure 6: Top 10 cities by annual losses in 2050 ($bn)

City	Average Annual Losses in 2050 ($bn)	Increase in AAL compared with 2005	AAL as a percentage of city GDP
Guangzhou	13,200	11%	1.46%
Mumbai	6,414	5%	0.49%
Kolkata	3,350	24%	0.26%
Guayaquil	3,189	13%	1.08%
Shenzen	3,136	7%	0.40%
Miami	2,549	21%	0.36%
Tianjin	2,276	26%	0.30%
NY—Newark	2,056	5%	0.08%
Ho Chi Minh	1,953	12%	0.83%
New Orleans	1,864	18%	1.42%

Source: ASR Ltd. / Hallegatte et al. (2013)

Conclusions

- **Risks posed by environmental change are becoming material within investment portfolios**
- **Pressure on the 'stress nexus' will increase and multiply**
- **Asset stranding will unevenly affect firms, sectors and investors – but these risks can be reduced**

Asset Stranding is likely to have an increasing impact on portfolio values in coming years…

Stranded assets can and are likely to have broad implications that will spread across the economy and through different asset classes. While not currently viewed as systemic, risks posed by stranded assets are becoming increasingly material to portfolio values. Such risks are already becoming evident and may become a key factor over shorter timeframes than expected by many asset managers. Uncertainty remains in the catalysts and tipping points of asset stranding scenarios, and these are likely to be different across markets and asset classes.

…few markets or sectors will be immune from the pressures that are already becoming evident

The effect of these pressures will, likely, increase and multiply, creating winners and losers in all asset classes. Specific sectors – principally coal – are more vulnerable to government regulation, whereas others are more at risk from physical climate stranding, including agriculture, coastal infrastructure and water-intensive operations such as mining and energy production.

Regional 'stranding' trends will see Northern Europe, Canada and Russia gain at the expense of many 'frontier' markets

Investors must consider the impact these events might have on the macro economy and national security. Investors need to be positioned to gain from asset stranding, and it is clear that certain sectors and regions will benefit relatively compared to others under climate change and asset stranding (such as Northern Europe, Canada and Russia).

Regulation and socio-political pressures will challenge asset managers to divest from fossil fuel assets

Likely increases in regulation, a boom in more cost-effective (economically, environmentally, and socially) alternatives, and growing socio-political pressure for change, should lead investors to reconsider the viability of fossil fuel assets as being profitable and sustainable in the future. Already some asset managers have announced a desire to divest from fossil fuel assets that are most likely to be stranded.

The issue for portfolio managers is at what point they will seek to identify the potential stranded asset risk in their own portfolios

Given the risks that have been identified already, prudent investors might look to identify stranding risks within their own portfolios, and consider these risks when making future long-term investment decisions. Investors can now report on their exposure to such risks through schemes including the Carbon Disclosure Project or the UN Principles of Responsible Investing.

Asset managers can begin to pro-actively re-price their Assets exposed to carbon risk or they may face more discrete risks at a future date.

Although it appears increasingly unlikely that the world will stay below this international target, even allowing the atmosphere to warm by 2°C will usher in a hostile climate, figuratively and literally, in which business would have growing difficulty in operating and assets would be prematurely devalued. Investors will increasingly have to choose between re-pricing (and de-risking) their carbon assets in the relatively near future or absorb the cost of inaction in the future by suffering perhaps more widespread stranding across industries and asset classes.

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