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INVESTING IN A TIME OF CLIMATE CHANGE:
CALIFORNIA STATE TEACHERS RETIREMENT SYSTEM PORTFOLIO CLIMATE CHANGE RISK ASSESSMENT

FEBRUARY 23, 2016

MARSH & McLENNAN COMPANIES

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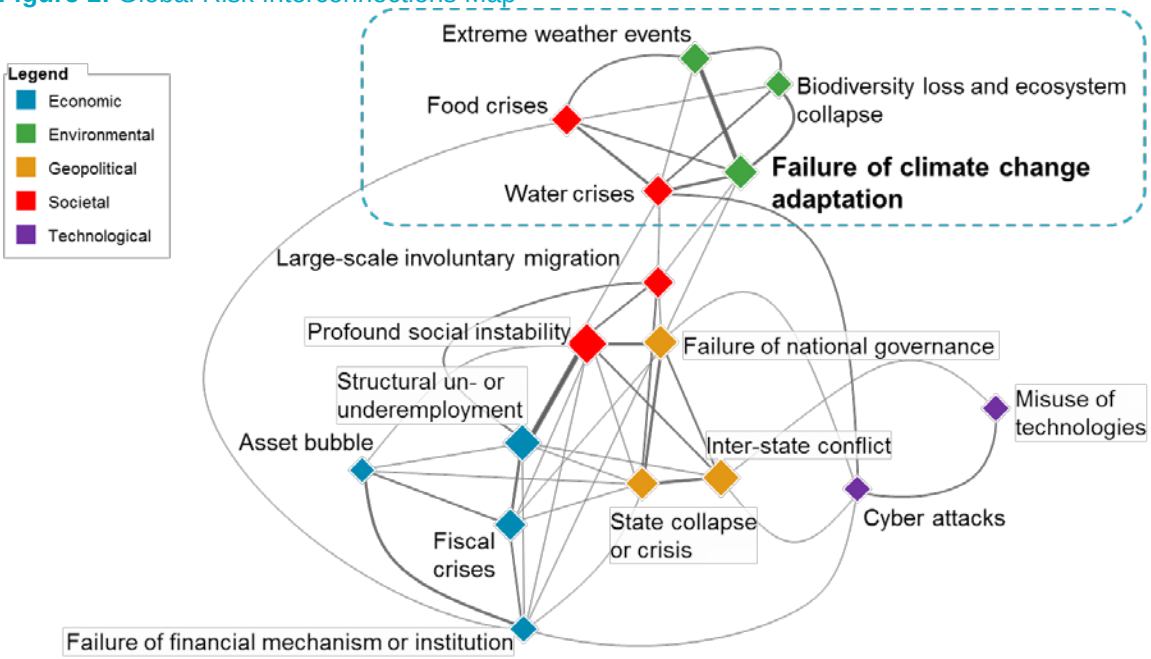
STUDY SYNOPSIS

AN INTERCONNECTED WORLD: CLIMATE CHANGE IS AN INVESTMENT ISSUE

While climate change as caused by human activities is an established scientific fact, there remains uncertainty around how climate change will develop and questions prevail, including:

- What level of temperature increase is the world heading for and how sensitive is the climate to GHGs? What are the implications for weather patterns, food and water security and global demographics?
- Now that a global climate change agreement has been reached who will the winners and losers be? Can society mitigate the risks in time?
- Will science and technology developments offer solutions? How quickly can we adapt?
- How will geopolitical relations develop? What will a model for sustainable growth look like?

Figure 1: Global Risk Interconnections Map



Source: World Economic Forum, Global Risks Report 2015

The complex world between future global economic development and climate change is an extremely difficult minefield to navigate. Figure 1 shows the magnitude and degree of interconnection between certain risks as identified by the World Economic Forum's Global Risk Report 2015. All of these pressing risks are influenced by climate change and the degree and

magnitude of their combined effect on the global economy – and by extension on investment returns – is important for long-term investors to understand. To help, we have used scenario analysis and adapted Mercer's prospective investment modeling tool to consider some of the potential future climate change pathways, the impact these may have from an economic perspective and the implications for investors.

TIMEFRAME DISCONNECT: A CHALLENGE FOR INVESTORS

One of the key challenges for investors in considering the risks and opportunities posed by climate change is the disconnect in timeframe between investor portfolio management and climate change impacts. Mercer's study focuses on a 35-year timeframe from 2015 to 2050. This is very long term from an investment perspective; typically, strategic investment advice is based on a modeling period of 10 years and investment managers take investment decisions on a 3-5 year timeframe, or less. However, climate change impacts become increasingly apparent post 2050 and climate models focus on 2100; extending out to 2300 and beyond. 2050 is short-term from a climate change perspective.

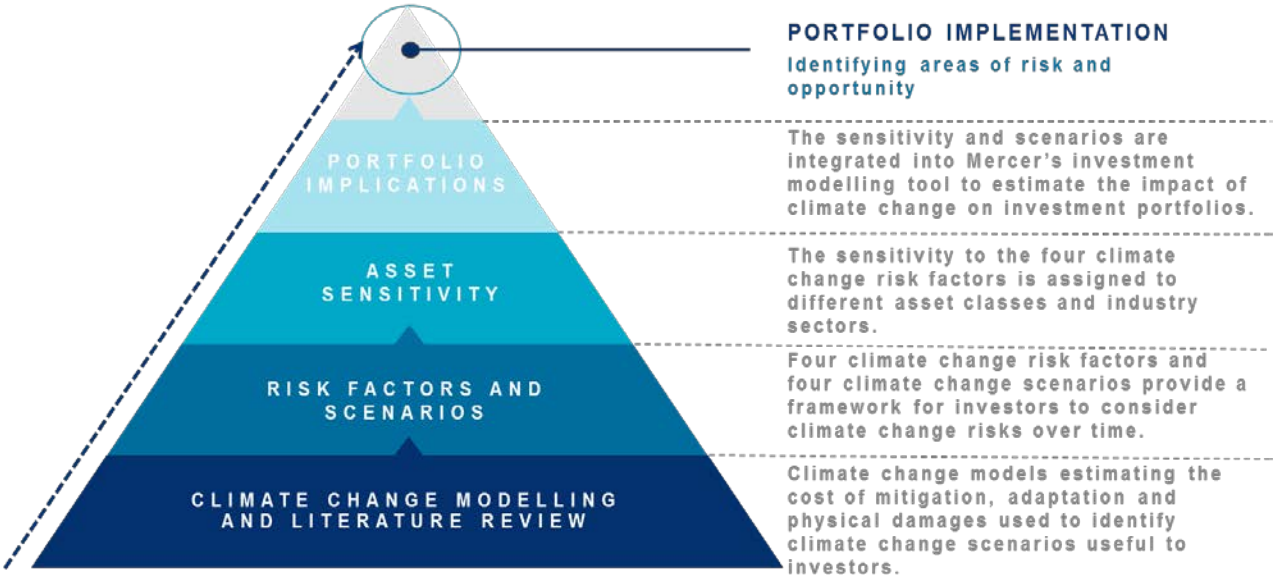
In particular, the physical impacts of climate change; such as extreme weather events and sea level rises are expected to be relatively limited over the period to 2050. Given CalSTRS remains open to both new entrants and future accruals, its liabilities should be expected to stretch out well beyond this time horizon. However, the further forward we look the greater the uncertainty in outcomes making it difficult to justify investment modeling beyond our 35-year timeframe. Nevertheless the post 2050 implications should not be ignored.

While there is notable dis-connect between the timeframe of investment decision-making and that of climate change considerations, there are nearer-term actions that investors can take and signposts that investors can monitor to better understand future climate change related developments.

STUDY APPROACH: FROM CLIMATE CHANGE MODELING TO INVESTMENT PORTFOLIO IMPLEMENTATION

There were 5 key stages to the study to consider the risk of climate change on investment portfolios, as set out in the diagram below.

Figure 2: Mercer's climate change risk modeling process



Source: Mercer

Given the uncertainty and complexity of future developments with respect to climate change, we used a scenario-based approach to considering the potential risks and opportunities.

CLIMATE CHANGE SCENARIOS

Four climate change scenarios were developed as part of the study, each reflecting different climate change policy ambitions that result in varying CO_2 emissions pathways, temperature outcomes and levels of economic damages related to climate change. These were developed using existing climate change integrated assessment models (IAMs) and through an extensive literature review.

Four scenarios, Transformation, Coordination, Fragmentation (Lower Damages) and Fragmentation (Higher Damages) were identified as collectively representing a reasonable range of potential outcomes and thereby useful for investors to consider climate change possibilities.

Figure 3: Climate change scenarios modeled

1. TRANSFORMATION	
Ambitious and stringent climate change policy and mitigation action put the world on a path to limiting global warming to 2°C above pre-industrial temperatures by the end of this century.	
Climate perspective	The most ambitious of the four scenarios considered in this study in terms of climate policy but also the most contentious. This scenario is the critical benchmark: from a scientific perspective it increases the chance of avoiding dangerous climate change, with international climate policy supporting the transformation to a low-carbon economy. However, some believe this scenario is already "off the table" as policy makers have not reacted quickly enough to date, with many pledges to reduce emissions not being met sufficiently. If Transformation is to occur, time is certainly of the essence and the results of the Paris negotiations late last year certainly increased its likelihood[1].
Investor perspective	Where change is fast, near-term and significant, investors that have not considered the risks and opportunities posed by climate change action are likely to be caught off guard. A Transformation scenario could cause significant shorter-term market volatility. Investors that have considered the risks and opportunities posed by climate change should be well positioned relative to those that have not considered such risks and would be expected to benefit from first-mover advantage relative to peers.

2. COORDINATION	
Climate change policy and mitigation actions are aligned and cohesive, keeping warming to 3°C above pre-industrial temperatures by the end of this century.	
Climate perspective	While not as ambitious as Transformation, this scenario assumes a coordinated and well-defined policy response to reduce emissions by 2030.
Investor perspective	Where change is more measured and anticipated, investors have more time to react and position their portfolios accordingly. Early movers would be expected to benefit in the shorter-term as the policy response becomes increasing apparent to the broader market. However, investors would need to be careful that policy transparency is not mistaken for adequacy in terms of the scale of ambition as this could cause investors to under-estimate the economic damages associated with the long-term physical impacts of climate change.

3. FRAGMENTATION (LOWER DAMAGES)	
Limited climate action and lack of coordination result in warming rising to 4°C or above from pre-industrial temperatures by the end of this century.	
Climate perspective	This scenario assumes a fragmented policy response (both by region and ambition) with limited additional action from policy agreements currently in place.

[1] For more on Mercer's perspectives regarding the Paris climate agreement see our Dispatch from COP21.

Investor perspective	If the policy response is disparate in terms of commitment and timing by region, an increased level of uncertainty is created for investors. In the shorter-term, a lack of policy action could lull investors into a false sense of security that it is business as usual, from a longer term perspective investors cannot afford to be complacent about structural economic change and emerging market policy. Those investors that have an increased understanding of the potentially divergent responses are likely to be better able to adapt their investment strategy by anticipating regional differences and positioning their portfolios accordingly.

4. FRAGMENTATION (HIGHER DAMAGES)	
Limited climate action and lack of coordination result in warming rising to 4°C or above from pre-industrial temperatures by the end of this century. The physical impacts of this warming are felt more severely.	
Climate perspective	This scenario follows the same CO_2 emissions pathway and policy response as Fragmentation (Lower Damages) but scales up the potential physical impacts of climate change.
Investor perspective	On top of the considerations highlighted for the Fragmentation (Lower Damages) scenario, investors with exposure to investments expected to be most sensitive to the physical impacts of climate change should monitor the risks posed by climate change carefully (particularly where investments are illiquid).

While the Transformation scenario is an ambitious benchmark and could be seen as a “best-case” scenario from a climate change perspective, the Fragmentation (Higher Damages) scenario is by no means a “worst-case” scenario. While it is the least favorable (from a climate change perspective) of the scenarios considered in the study, it broadly equates to a temperature warming of 4°C and is consistent with existing policy commitments. Should countries renege on existing commitments, there is the potential for a more divergent and negative outcome to occur (resulting in a level of warming higher than 4°C).

THE BUILDING BLOCKS OF THE CLIMATE CHANGE SCENARIOS AND THE IMPORTANCE OF 2°C

GREEN-HOUSE GAS (GHG) EMISSIONS: There is now wide spread scientific consensus that man-made GHG emissions are the dominant cause of the climate change observed over the past half century. Carbon dioxide (CO_2) is the most prevalent GHG and therefore CO_2 emissions are used as a proxy for GHG emissions more broadly. The level of atmospheric warming is directly related to the level of GHG emissions and so CO_2 emissions pathways are an indicator of the potential extent of warming.

LEVEL OF TEMPERATURE WARMING: The most common reference is the rise in temperature above pre-industrial levels. All major countries, including the US and China, have recognised the scientific evidence that limiting global warming to 2°C is required to avoid "dangerous" interference with the climate. If temperature increases exceed this level, the world starts to rapidly increase its risk exposure. It is important to note that even if the world stopped all GHG emissions tomorrow, it would still be 'locked in' to a degree of further global warming, which is currently estimated to be 1.5°C (Source: World Bank Group, Turn Down the Heat).

MITIGATION ACTIVITIES: Human intervention to limit climate change and the resulting impacts by reducing GHG emissions (e.g. through subsidies to increase the deployment of renewable energy) or increasing GHG 'sinks' (e.g. through afforestation). Mitigation refers to efforts to limit the cause of warming in the first place.

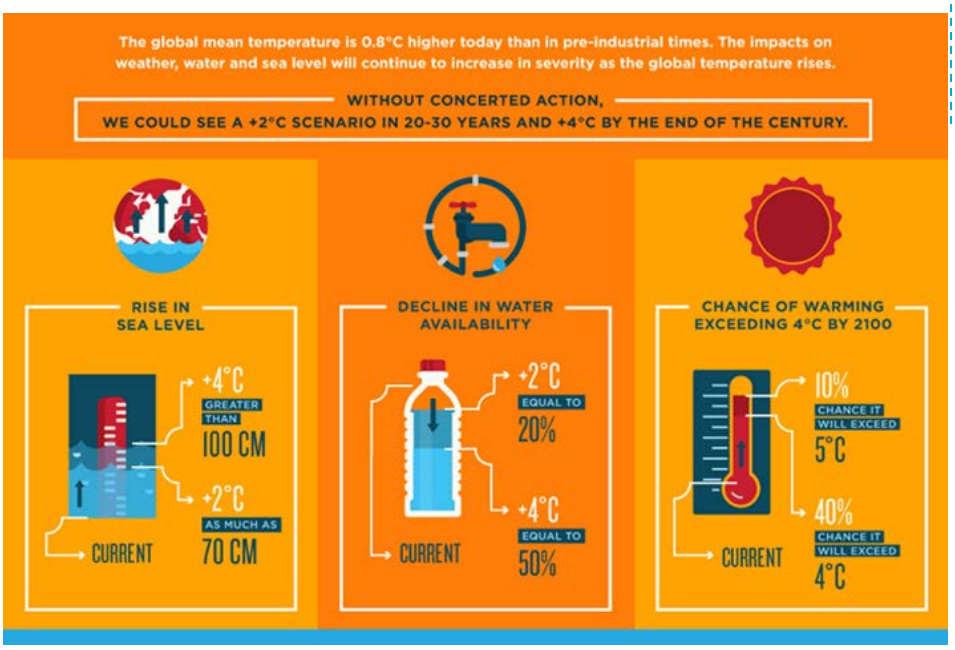
ADAPTATION ACTIVITIES: Protecting against the impacts of climate change (e.g. building flood walls). Adaptation refers to managing the warming that occurs by making changes in the physical landscape or improving the financial capacity of individuals or entities to withstand climate events.

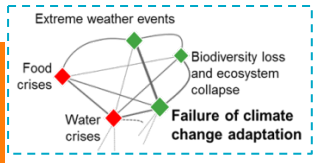
MITIGATION VERSUS ADAPTATION: The greater investment made in mitigation activities today, the less investment will be required in adaptation activities in the future. The inverse unfortunately is not also true. While investment in adaptation today will improve resilience tomorrow, without some degree of mitigation the impact of climate change is likely to increase unabated until adaptive capacity is overwhelmed.

ECONOMIC DAMAGES: The level of economic damages caused by climate change based on how sensitive the climate and the economy are to future levels of CO_2 concentrations.

The diagram below from the World Bank Group highlights some of the changes that may occur across different levels of temperature warming and links back to the global risks considered by the World Economic Forum.

Figure 4: Considering different levels of warming: putting the Mercer scenarios into context





Source: World Bank Group, Turn Down the Heat

In order to consider the impact on investment returns and volatility under the different climate change scenarios, Mercer identified four climate change risk factors that can be used to translate each of the climate change scenarios (based on the outputs of the climate change modeling and literature review) into the language of investments. This allows us to build the climate change scenario pathways into the investment modeling tool.

CLIMATE CHANGE INVESTMENT RISK FACTORS

This study built on Mercer's previous work to consider four climate change related investment risk factors: Technology, Resources, Impact of Physical Damages and Policy, together known as the "TRIP" factors.

Figure 5: Mercer's TRIP climate change risk factors

TECHNOLOGY (T)

The rate of progress and investment in the development of technology to support the low-carbon economy.

The Technology factor captures technological advancement and the opportunity for increased efficiency through technological change.

The speed, scale and success of low-carbon technologies, coupled with the extent of transformation and disruption of existing sectors, or development of new sectors, are key considerations for investors.

RESOURCE AVAILABILITY (R)

The impact of chronic weather patterns (e.g. long-term changes in temperature or precipitation).

Resource availability is a new aspect being added to the previous Mercer study to identify how changes to the physical environment might impact investments reliant on the use of resources, such as water and agricultural resources at risk of becoming scarcer or, in some cases, more abundant over the long-term as a result of changes to weather patterns. The impacts on agriculture, energy and water are key.

IMPACT OF PHYSICAL DAMAGES (I)

The physical impact of acute weather incidence (i.e. extreme or catastrophic events).

This factor can be interpreted as the economic impact of climate change on the physical environment caused largely by changes in the incidence and severity of extreme weather events.

Examples include damage to property caused by flooding as a result of sea level rises; damage caused by hurricanes and damage caused by wildfire.

POLICY (P)

Collectively refers to all international, national, and sub-national regulation (including legislation and targets) intended to reduce the risk of further man-made climate change.

This factor can be interpreted as the level of coordinated ambition of governments to adopt and adhere to policies and regulations to reduce green-house gas emissions.

Examples of climate-related policy include green-house gas emissions targets, carbon pricing, subsidies and energy efficiency standards.

Policies can be classified into those that focus on the supply side (by encouraging the substitution of high emission products with lower emission alternatives) and those that focus on the demand side (by reducing demand for high emission products).

CLIMATE CHANGE SIGNPOSTS FOR INVESTORS

By considering the climate change scenarios through the lens of our climate change risk factors, we are able to highlight signposts that investors can monitor in order to be prepared for changes that may occur as a result of climate change. We have focused on the following elements; each represented by our TRIP factors, that we believe are important signposts for investors:

- The timeframe of CO_2 emissions peaking, potential changes in the energy mix out to 2050 and modeled mitigation cost estimates
- The rate of investment required in technologies designed to facilitate the transition to a low-carbon economy
- Potential shifts in long-term weather patterns and resultant economic impacts as a result of global warming
- Potential shifts in the level of economic damages caused by shifts in the frequency and/or severity of catastrophic weather events, such as floods and hurricanes.

The table below outlines the investor signposts under each of the scenarios by risk factor. Development against these signposts will allow investors to consider the likelihood of different climate change scenarios as additional evidence is presented.

Figure 6: Key signposts for investors by climate change scenario (to 2050)

SIGNPOST FOR INVESTORS	TRANSFORMATION	COORDINATION	FRAGMENTATION LOWER DAMAGES	FRAGMENTATION HIGHER DAMAGES
Potential changes to the energy mix T	Significant change to the energy mix: fossil fuels represent less than half of the energy mix at 2050.	Fossil fuels represent circa 75% of the energy mix at 2050.	Fossil fuels continue to be the dominant energy source, representing 85% of the energy mix at 2050.	
Rate of investment in technologies supporting the low-carbon economy T	Cumulative investment of US$65 trillion in energy supply and efficiency (ex-fossil fuels) required over 2015–2050.	Cumulative investment of US$47 trillion in energy supply and efficiency (ex-fossil fuels) required over 2015–2050.	Total energy investments increase to US$3.13 trillion in 2050. Limited investment into low-carbon energy.	
Potential shifts in long-term weather patterns and impact on resource availability R	Limited impact by 2050.	Limited impact by 2050.	Estimated net benefit from resource availability as a percentage of global GDP of 0.5% at 2050. Driven by gains in agriculture, partially offset by losses related to biodiversity.	Estimated net loss from resource availability as a percentage of global GDP of 0.8% at 2050. Driven by losses due to energy, water, and biodiversity.
The level of physical damages caused by catastrophic events, such as floods and hurricanes I	Limited impact by 2050; driven by losses from (extra) tropical storms and coastal flood.	Limited impact by 2050; driven by losses from (extra) tropical storms and coastal flood.	Estimated net loss as a percentage of global GDP of 0.4% at 2050. Driven by losses from (extra) tropical storms and coastal flood.	Estimated net loss as a percentage of global GDP of 0.7% at 2050. Primarily represents losses from wildfire, coastal flood, and extreme temperatures.
Global policy response P	Most effective from a climate change mitigation perspective, Aggressive introduction of carbon pricing, and related policy / regulation, likely to result in shock to financial markets.	Existing policy pledges with respect to carbon emissions are implemented with mitigation efforts extended to 2030.	Divergent with limited efforts beyond existing pledges. Although a reduction in emissions of 10% (versus 2010 levels) is achieved by 2050 in developed markets, this is outweighed by increases in emissions in emerging markets.	
Expected cost of carbon ($US2013/t CO2) P	Global carbon pricing introduced relatively swiftly, then flattening out to around $180 by 2050.	Global carbon pricing introduced more slowly, picking up pace after 2030 and reaching $210 in 2050.	Lack of development of a global carbon price recognized by the market.	

Global greenhouse gas emissions at 2050[2] P	22 Gt CO_2e/yr. 56% decrease vs. 2010 levels.	37 Gt CO_2e/yr. 27% decrease vs. 2010 levels.	67 Gt CO_2e/yr. 33% increase vs. 2010 levels.
Timeframe for emissions level peaking P	Emissions peak by 2020.	Emissions peak by 2030.	Emissions peak after 2040.

HOW SENSITIVE ARE DIFFERENT INVESTMENTS TO CLIMATE CHANGE?

Now that we have identified how different climate change scenarios may develop to 2050 by looking at how the four climate change risk factors progress in terms of influence over time, the next stage is to consider how sensitive different investments are to the climate change risk factors. By combining the development of the TRIP factors over time with the sensitivity of different investments to the TRIP factors we are able to look at the potential impact of climate change on CalSTRS investments.

Mercer has developed climate change sensitivity heat maps that summarize our assessment of the sensitivity of different asset classes and industry sectors to the TRIP factors. We have assigned sensitivity on a relative basis using a scale of -1 where we expect the most negative impact on investment returns, to +1 where we expect the most positive impact on investment returns.

While investors do not typically consider industry level detail when making strategic investment decisions, it is necessary to “drill-down” to this level due to the disparity of sensitivity across different industries. We have focused our attention on those industries we believe to be of most interest for this study; those that are expected to be the most sensitive to climate change. Although we have not looked at security level analysis as part of this study, it is crucial that CalSTRS understands where risks and opportunities might lie and to ensure that its investment managers are fully considering these risks when building portfolios, particularly when investing in asset classes, industries and sectors with the highest sensitivity.

[2] CO_2e, stands for carbon dioxide equivalent. It expresses the impact of different green-house gases in terms of the equivalent amount of CO2 that would create the same amount of warming. This enables a carbon footprint consisting of lots of different green-house gases to be expressed as a single number.

STRUCTURAL CHANGE: PAST PERFORMANCE IS NOT A GUIDE TO FUTURE PERFORMANCE

A particularly difficult task for investors is in identifying and managing structural changes. The greater the level of change, the more disparity between the winners and losers, and today's "giants" often become tomorrow's "dinosaurs", as those that fail to adapt are left behind. Such changes can create new industries at the expense of existing industries.

It remains very difficult to capture long-term forward-looking changes within quantitative investment modeling processes, and although we know that in practice long-term, sustainable global economic growth is not going to follow the same path as historical economic growth, we have not sought to reflect these uncertain future structural changes within our investment modeling. Therefore:

- **Industry classification is based on today's definition:** We have not made allowance for new industries and/or any re-classification that would be expected as markets reflect the adaptation to a low-carbon economy.

- **We have not attempted to forecast changes in the regional composition of global equity indices:** However, over the period modeled to 2050, we would expect certain nations currently classified as emerging markets to be re-classified to developed markets.

- **There is a "negative bias" to the heat maps (that is, more red than green), as a result of our analysis being based on a starting point of today:** We recognise that there will be opportunities created and that across different industries and regions there will be winners and losers, as some companies will adapt business models accordingly and others will not. Within industries and sectors there will continue to be different supply and demand drivers, including those industries where overall sensitivity may be neutral.

Figure 7: Sensitivity to the climate change risk factors: asset class level

ASSET CLASS	T	R	I	P
Developed Market Global Equity	<0.25	>-0.25	>-0.25	>-0.25
Emerging Market Global Equity	<0.25	-0.25	-0.50	<0.25
Low Volatility Equity	0.00	>-0.25	>-0.25	>-0.25
Small Cap Equity	<0.25	>-0.25	>-0.25	>-0.25
Developed Market Sovereign Bonds	0.00	0.00	0.00	0.00
Investment Grade Credit	<0.25	>-0.25	>-0.25	>-0.25
Multi Asset Credit	0.00	0.00	>-0.25	0.00
Emerging Market Debt	0.00	>-0.25	-0.25	<0.25
High Yield Debt	0.00	>-0.25	-0.25	>-0.25
Private Debt	0.00	0.00	0.00	0.00
Global Real Estate	<0.25	0.00	-0.75	<0.25
Private Equity	<0.25	>-0.25	-0.25	>-0.25
Infrastructure	0.25	>-0.25	-0.50	<0.25
Timber	<0.25	-0.75	-0.50	0.25
Agriculture	0.25	-1.00	-0.50	0.25
Hedge Funds	0.00	0.00	0.00	0.00

Negative Positive

- Growth assets, such as equities, are more sensitive to climate change than defensive assets, such as sovereign bonds.
- Global developed market equities are expected to have a negative sensitivity to policy and a positive sensitivity to technology. Emerging market equities are expected to benefit from additional climate change policy and technology developments, which should help to protect long-term sustainable economic growth in emerging markets.
- Within bonds, emerging market and high yield debt are the most sensitive to the risk factors.
- Real estate, agriculture and timberland have the greatest negative sensitivity to the impact of physical damages and resource availability. Agriculture and timberland are the most sensitive (positive) to policy while infrastructure and agriculture have the greatest positive sensitivity to technology.
- We do not expect private debt or hedge funds, in aggregate, to be sensitive to the risk factors.

Figure 8: Sensitivity to the climate change risk factors: industry and sector level

INDUSTRY SECTOR	T	R	I	P
ENERGY	-0.25	-0.75	-0.75	-0.75
Oil	-0.50	-0.75	-0.75	-0.75
Gas	<0.25	-0.50	-0.75	<0.25
Coal	-0.50	-0.75	-0.75	-1.00
Renewable	0.50	-0.25	-0.25	1.00
Nuclear	0.50	-0.75	-0.25	0.50
UTILITIES	-0.25	-0.75	-0.50	-0.50
Electric	-0.50	-0.75	-0.50	-1.00
Gas	-0.25	-0.75	-0.25	-0.50
Multi	-0.25	-0.75	-0.50	-0.75
Water	-0.25	-0.50	-0.25	-0.75
MATERIALS	<0.25	-0.75	-0.25	-0.50
Metals and mining	<0.25	-0.75	-0.25	-0.75
INDUSTRIALS	<0.25	>-0.25	-0.50	-0.25
Transport and infrastructure	<0.25	>-0.25	-0.75	<0.25
CONSUMER DISCRETIONARY	0.00	0.00	0.00	>-0.25
CONSUMER STAPLES	0.00	-0.25	0.00	>-0.25
HEALTH	0.00	<0.25	<0.25	0.00
FINANCIALS	0.00	>-0.25	-0.50	0.00
IT	<0.25	0.00	0.00	0.00
TELECOMMUNICATIONS	0.00	0.00	>-0.25	0.00

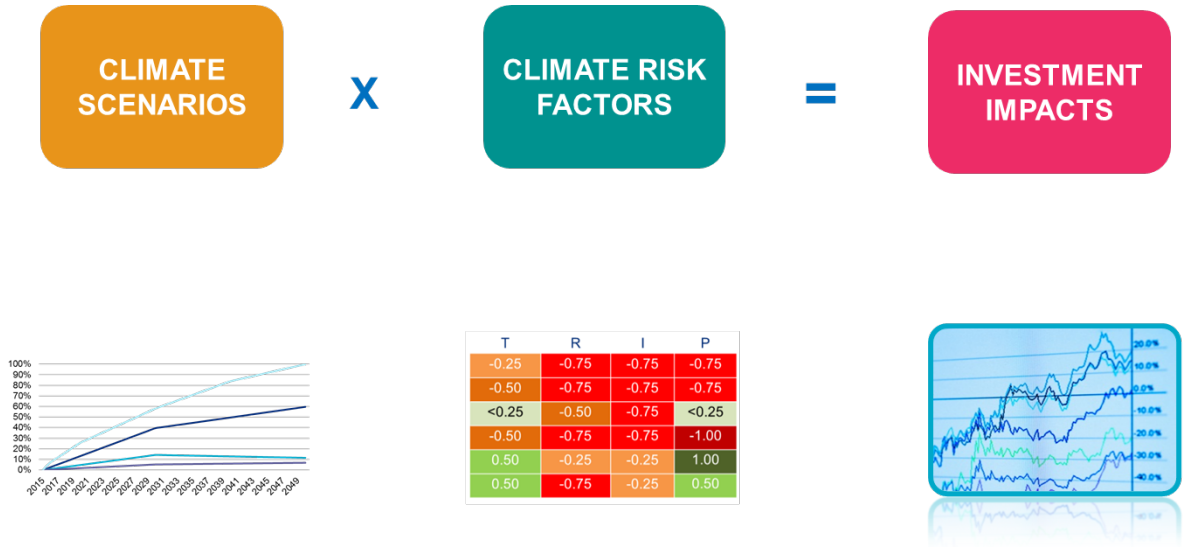
Negative — Positive

- Policy is the most significant risk factor in terms of sensitivity. The industries expected to be most sensitive are energy and utilities and the sectors with the highest negative sensitivity to policy are coal and electric utilities while renewables has the highest positive sensitivity.
- Energy and utilities have the greatest negative sensitivity to resource availability and physical impacts, with industrials also sensitive to physical impacts.

- Within each sector there will be winners and losers at a security level, including those sectors where overall sensitivity is expected to be neutral. Corporate debt could be subject to downgrade and defaults.

STUDY HIGHLIGHTS: COMBINING THE SCENARIOS AND RISK SENSITIVITY

Figure 9: Illustrative description of climate change investment impact calculation



The risk factor sensitivities which we developed based on fundamental quantitative and qualitative research represent the “absolute” exposure of each industry sector/asset class to each risk factor generally and thus do not change across scenarios or over time. However the relative magnitude of each risk factor’s influence on returns does change across time and scenarios. These shifts are represented by scenario scripts which define the relative influence of each risk factor on returns over time under each scenario. Multiplying these scripts by the risk factor sensitivities using a stochastic process enables the production of a host of investment return impacts and related findings. These include the following highlights:

- Over the long term (35 years), for a well-diversified portfolio, a Transformation scenario need not jeopardize overall financial return even if no action is taken to limit negative impacts and capture upside at the sector or asset class level. Meaning the economic implications of short-term policy action to combat further GHGs does not impact investors negatively over the long term.
- The Fragmentation (Higher Damages) scenario is increasingly detrimental to returns over time, whereas the Transformation scenario becomes increasingly favorable relative to the other scenarios.
- At a total portfolio level, under the Transformation scenario, while the overall impact is less significant (given positive and negative impacts for different asset classes) there are key areas that investors should focus on: e.g. regional equities (e.g. developed vs. emerging market) and real assets.

- The Coordination scenario typically has less severe impacts then Transformation or Fragmentation (Higher Damages), though nevertheless warrants attention since such an outcome may be more likely by some accounts.

The most apparent differential between climate change winners and losers appears at the asset class and equity sector levels where investors can position their exposures accordingly to manage downside risks as well as capture favorable opportunities. The range of potential return impacts across modeled scenarios at the asset class and equity sector levels are shown in Figure 10 and Figure 11.

Figure 10: Climate impact on return by industry sector (35 years)

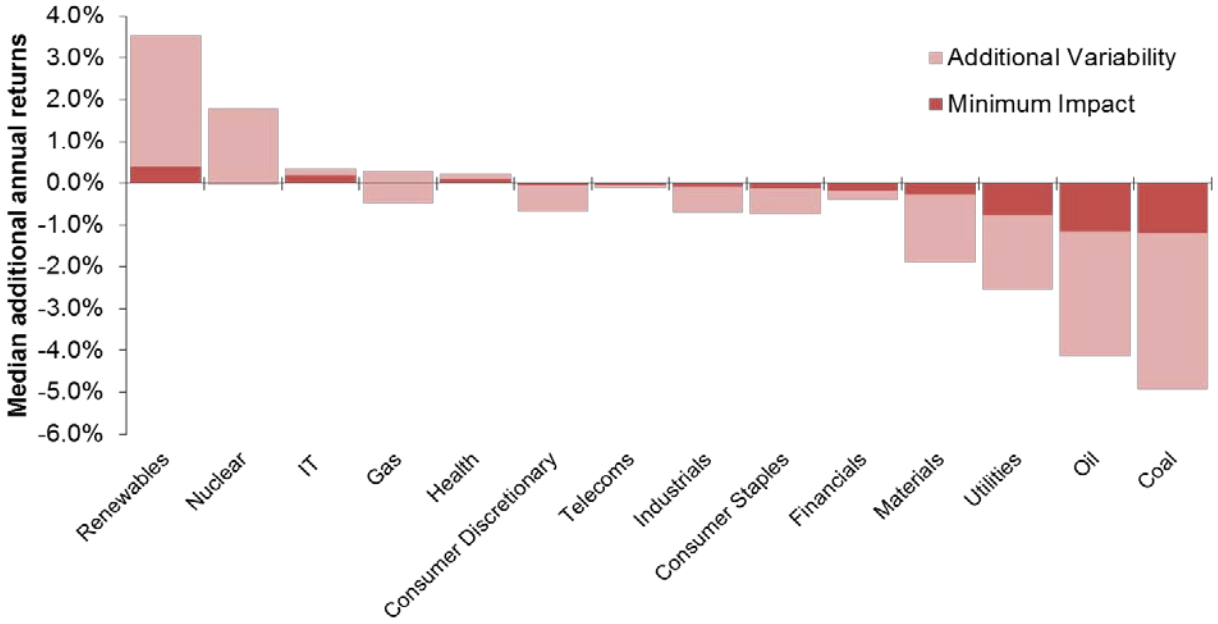
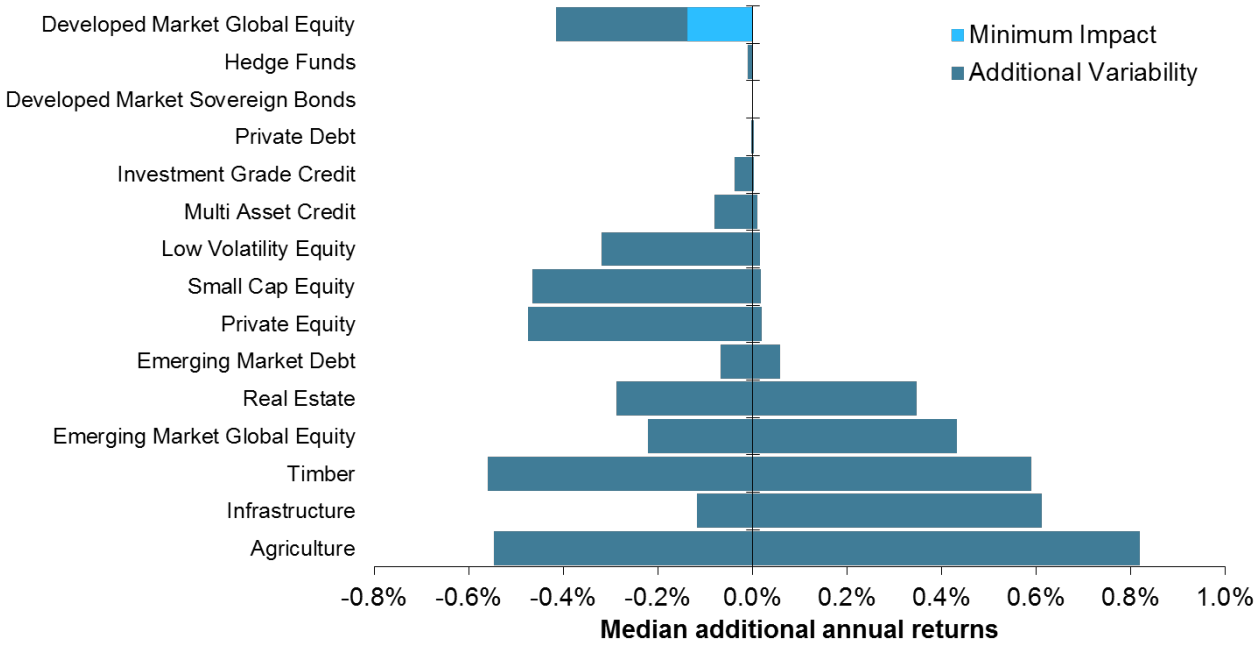


Figure 11: Climate impact on return by asset class (35 years)



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ANALYSIS AND KEY FINDINGS

Mercer has reviewed the climate risk exposures of CalSTRS using our TRIP factor framework and considering the portfolio impacts under the four climate change scenarios described herein.

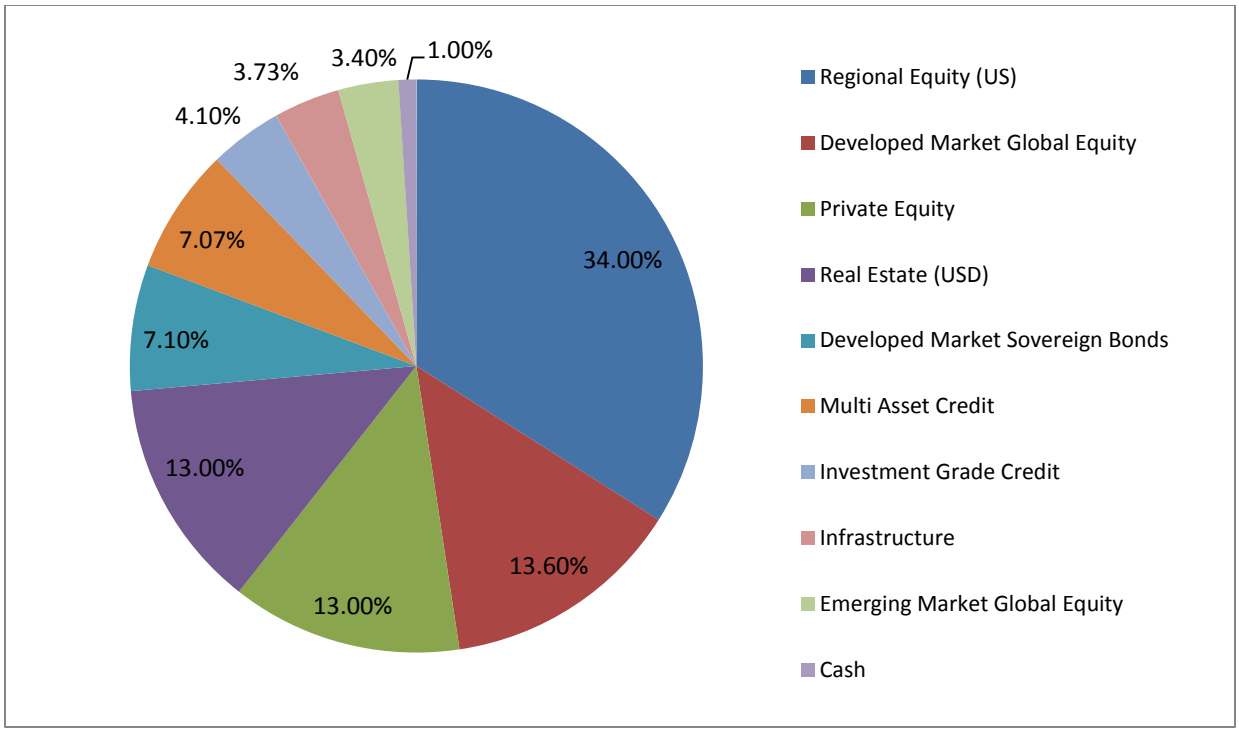
CURRENT STRATEGIC ASSET ALLOCATION

Asset allocation details were provided by CalSTRS as follows:

Figure 12: CalSTRS Modeled Asset Allocation[3]

Asset Class	CalSTRS Long-Term Target (as of June, 2015)
Regional Equity (US)	34.00%
Developed Market Global Equity	13.60%
Private Equity	13.00%
Real Estate (USD)	13.00%
Developed Market Sovereign Bonds	7.10%
Multi Asset Credit	7.07%
Investment Grade Credit	4.10%
Infrastructure	3.73%
Emerging Market Global Equity	3.40%
Cash	1.00%
Total	**100%**

[3] This table represents CalSTRS' strategic asset allocation as opposed to its realized asset allocation.



SUMMARY OF KEY FINDINGS

The impact of climate change on the total portfolio is variable across scenarios and potentially significant.

After assessing the aggregate impact of the TRIP factors under each climate scenario on CalSTRS' total portfolio we find it would be reasonably well insulated from loss under Coordination and Fragmentation (Lower Damages) scenarios. However it would be quite vulnerable under a Transformation scenario where CalSTRS could see a -0.32% per annum impact on median returns over the coming decade and a -0.17% per annum impact on median returns over 35 years. For $192 billion[4] in assets invested in 2015 this relates to a cumulative loss to CalSTRS of approximately $12 billion by 2025 and $123 billion by 2050[5]. CalSTRS would also be increasingly vulnerable to a Fragmentation (Higher Damages) scenario over time

[4] Approximate total fund balance as of June, 2015.

[5] These figures are based off of a comparative analysis of CalSTRS portfolio between a baseline no-climate-change scenario and Transformation outputs using linear median return calculations (Fund Value * ((1+Expected Return) ^ N Years)). Without the influence of climate change our baseline median annual portfolio return expectations are 7.93% over 10 years and 7.27% over 35 years.

with median annual return impacts of -0.12% over the 35-year time horizon leading to a cumulative loss to CalSTRS of $83 billion by 2050[6].

CalSTRS' total portfolio would be most negatively impacted by a Transformation scenario due to large allocations to developed market equity.

Given the strength and scale of response required to place the economy on a 2°C trajectory, the impact of the TRIP factors on investment portfolio returns is strongest under the Transformation scenario. Both the US and Developed Market Equity asset classes – which together make up nearly half of CalSTRS' total exposures – are expected to be negatively impacted. Add Private Equity into the mix (which is assumed to have a beta of 1.5 vs. US Equity and is therefore more sensitive to the push and pull of our TRIP factors *in extremis*) and exposures with negative median return impacts at the 35-year and 10-year time horizons would account for over 60% of CalSTRS total fund. CalSTRS can seek to address these risks through the following activities (some of which are already underway):

- Reallocating a portion of passive exposures towards lower-carbon indices or exploring other forms of alternative indexing.
- Allocating a (larger) portion of active equities towards thematic manager(s) focused on sustainability and/or green/resilient investments.
- Increasing exposure to Emerging Market Equity (public or private), which is expected to be positively impacted under a Transformation scenario, keeping in mind other macro factors influencing the attractiveness of the region, or taking other steps to diversify growth assets.
- Updating CalSTRS' engagement strategy with clear objectives focused on gaining clarity from holding companies about their "2°C business plans" (whether conducted through passive managers, active managers and/or directly by CalSTRS).

CalSTRS' active equity managers have sector exposures largely in line with their respective benchmarks.

While some slight sector tilts in CalSTRS active equity mandates across geographies might offer protection against climate change outcomes, these are not significant by comparison to the more deliberate tilts away from highly exposed sectors – notably Energy and Utilities – exhibited by sustainability-themed managers. CalSTRS active equity managers thus are not well positioned altogether to withstand adverse climate change outcomes versus passive alternatives. To address this CalSTRS might consider allocating a (larger) portion of active equities towards thematic manager(s) focused on sustainability and/or green/resilient investments. A more deliberate approach to climate change risk management at the portfolio level might also be warranted with strategic allocations to active mandates looking to take more advantage of/protect against related structural economic shifts, whether gradual or abrupt.

[6] Ibid

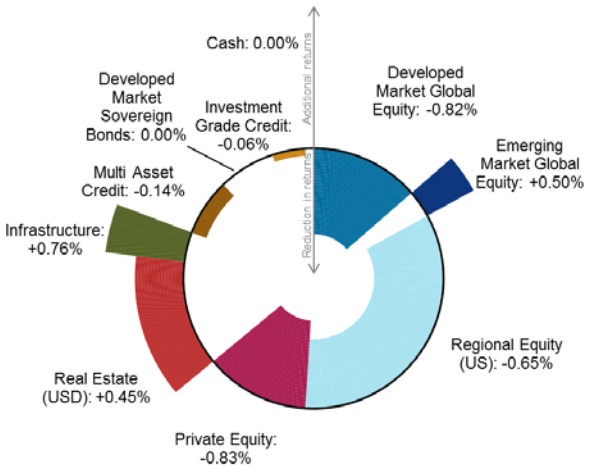
ASSET CLASS IMPACTS

The following circle charts illustrate where asset classes are expected to experience a gain or reduction in median returns, when considering climate risk. The black circle represents the total portfolio, with the width of each colored bar reflecting the size of allocation to a given asset class. Asset classes that are expected to experience a reduction in returns under a specific scenario will move towards the center of the circle, and asset classes that are expected to experience additional returns will move outwards from the circle.

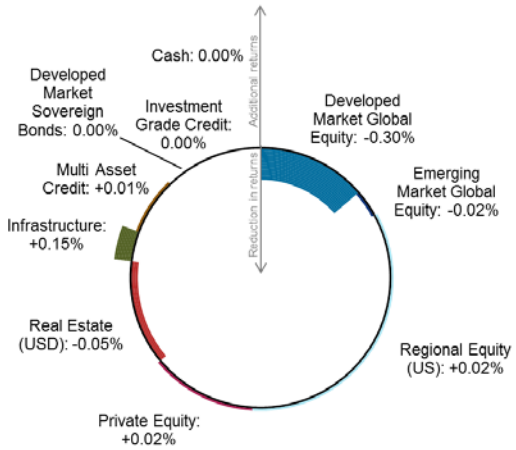
Figure 13: Median asset class return impacts at 10 years

Total Fund (10-year median return impact)

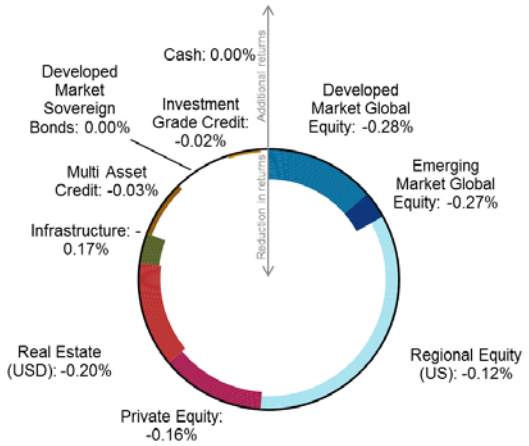
Transformation



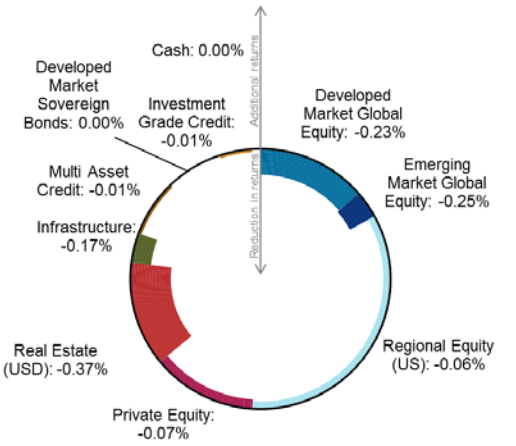
Coordination



Fragmentation (Lower Damages)



Fragmentation (Higher Damages)



Asset class implications – 10 years

- Under the Transformation scenario just over 60% of CalSTRS' assets suffer a significant loss (-0.65% to -0.83%). This is only partially offset by gains in Real Estate and Infrastructure (+0.45% to +0.76%), which collectively represent 16.73% of CalSTRS' target portfolio. Defensive assets – including Cash, Investment Grade Credit (IGC),

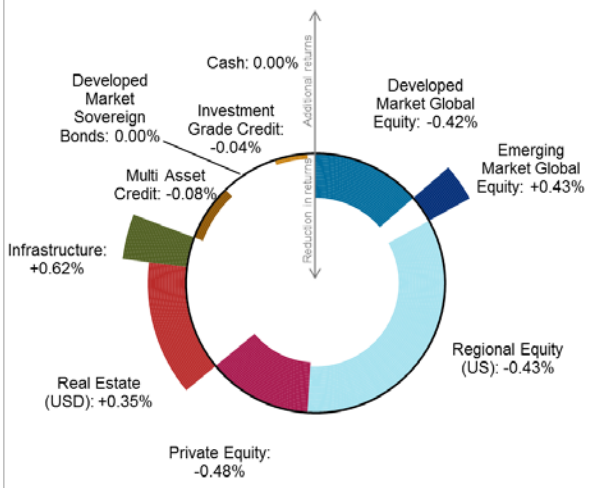
Multi-Asset Credit (MAC) and Sovereign Bonds – account for the remainder of CalSTRS exposure and are insulated from the impacts of Transformation relative to growth asset classes. However, relative to their own lower expected returns IGC and MAC experience notable losses.

- Under the two Fragmentation scenarios, all asset classes suffer losses meaning there are no winners to offset negative impacts at the asset class level. In these scenarios to capture any upside from climate change, efforts will be needed to identify opportunities within asset classes at the industry sector or individual company levels.
- With the exception of meaningful impact on Developed Market Global Equities, the total fund is relatively insulated from a Coordination scenario at the 10-year time horizon.

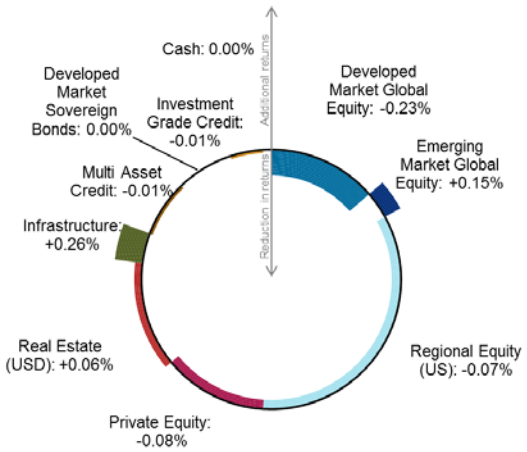
Figure 14: Median asset class return impacts at 35 years

Total Fund (35-year median return impact)

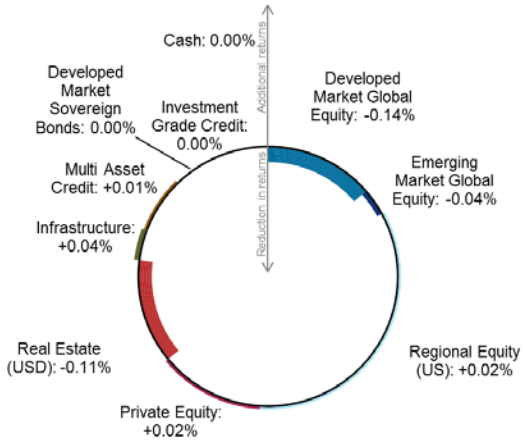
Transformation



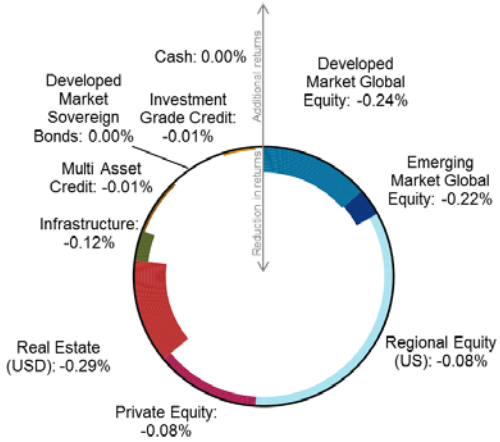
Coordination



Fragmentation (Lower Damages)



Fragmentation (Higher Damages)



Asset class implications – 35 years

- Annualized median return expectations at the 35-year time horizon are directionally similar and less severe (e.g. closer to zero) versus those at the 10-year time horizon for almost all asset classes with the following exceptions:
  - **Coordination**: Under the Coordination scenario in the 25 years between

snapshots return values switch from a loss to a slight gain for Real Estate and median annual returns increase by 11 bps for Infrastructure. This switch is the result of steady strengthening in the T and P risk factor signals over time to which such tangible asset classes are positively exposed. o **Fragmentation (Higher Damages)**: Expectations of median return drag stay stable or extend marginally for several asset classes in 2050 vs. 2035 under this scenario. This reflects in part the growing strength of the R and I risk factor signals over time and the significant vulnerability of most asset classes to these risks.

Considering Mitigation vs. Fragmentation Scenarios

The **Transformation** and **Coordination** scenarios envision stronger levels of mitigation than we see in the Fragmentation scenarios, with the Policy and Technology risk factors representing the most significant influences.

- If CalSTRS places a reasonable probability on the likelihood of one of these scenarios eventuating, it should take action to manage the Policy risk in its equity portfolios and seek to gain exposure to investments that are expected to respond positively to the Technology risk factor.
- If CalSTRS views the **Transformation** scenario as reasonably plausible, then equal focus should be placed on managing Policy risk in its Public and Private Equity portfolios. However, under the **Coordination** scenario, US and Private Equity are less negatively impacted.
- The Technology factor is a strong signal in both mitigation scenarios, and should lead to positive positioning for companies focused on providing solutions for the transition to a low-carbon economy.
- The **Fragmentation** scenarios also see negative impact for equities, but this would be driven more by the Resource Availability and Impact factors. This leads logically to a larger focus on climate risk management versus policy risk management from an equities perspective. The Fragmentation scenarios would also more heavily impact real estate and infrastructure holdings, which may in this case warrant increased risk assessment regardless given the extent to which the physical effects of climate change have already been “baked in” to the global climate system.

TOTAL PORTFOLIO IMPACTS

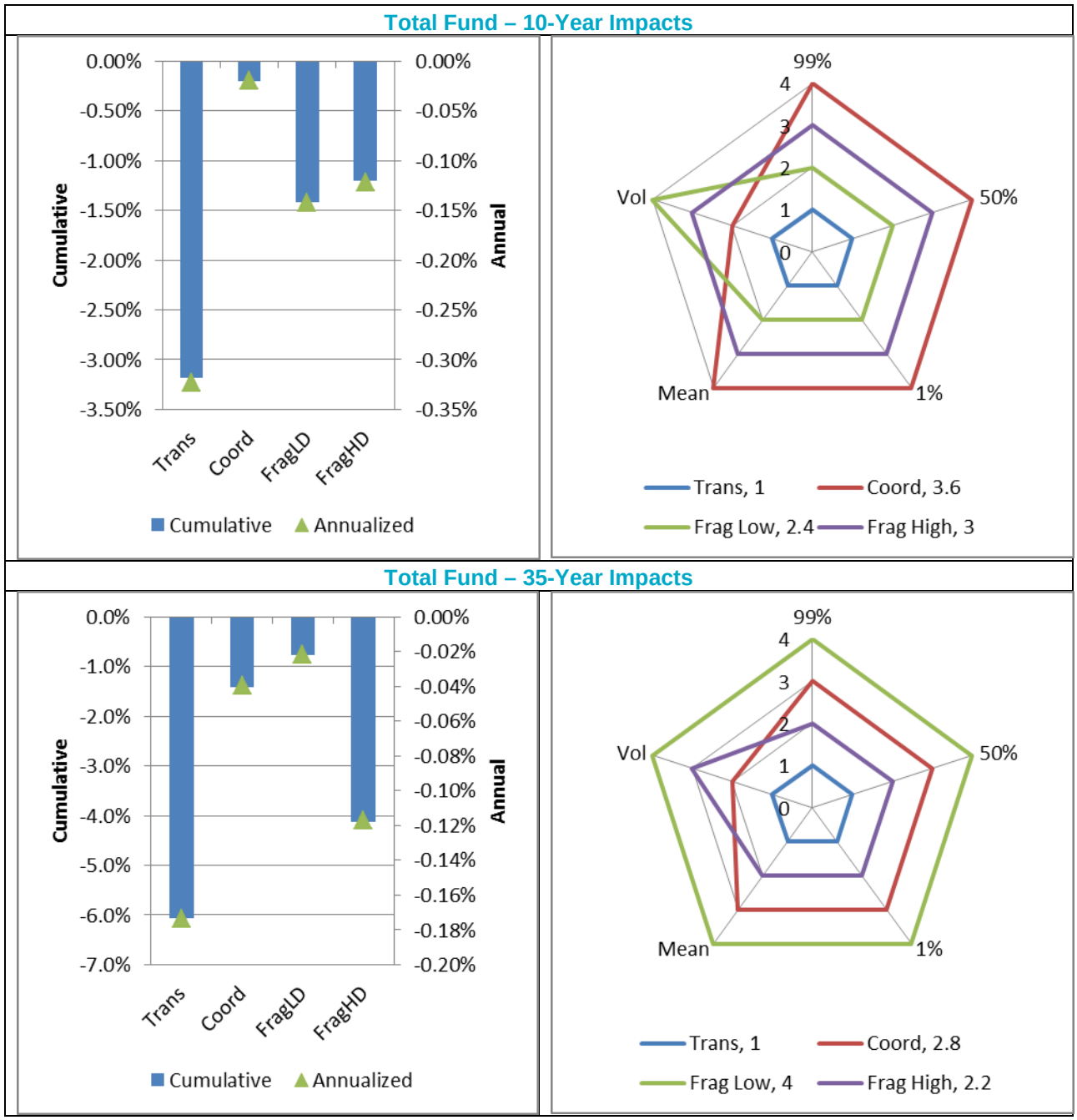
For the purposes of quantifying total fund impact, we have assessed the aggregate influence of each scenario on CalSTRS’ portfolio, as shown in Figure 13. Two means of assessment are depicted. The bar chart shows the cumulative impact of climate change on total fund returns at the median for each scenario and time frame. The “spider web” graphic shows the relative performance of CalSTRS’ portfolio under each scenario based on a discrete set of metrics including the median return outcome, the mean return outcome, two return outcomes on the distribution tail (95% and 1%) and return volatility (for a discussion of the volatility metric in particular refer to the Technical Addendum delivered to partners as part of the public report). The values shown after the scenario name in the legends of these graphics correspond to the average score of each scenario across the five factors equally weighted. An easy way to interpret these charts is to look at the surface area encompassed by each scenario line – CalSTRS’ portfolio performs the best under the scenario with the most coverage.

From these graphics the Transformation scenario stands out as the most adverse for CalSTRS’ portfolio. Stated otherwise the modeled CalSTRS portfolio would be most negatively impacted by a scenario resulting from significant policy action to limit future GHG emissions or encourage low-carbon growth. This is true at both the 10- and 35-year time horizons where the Transformation results are the worst cumulatively and score lowest on all five measures of portfolio resilience used in the comparative spider diagram. The CalSTRS portfolio would be

most insulated from loss under the Coordination scenario at the 10-year time horizon and under the Fragmentation (Lower Damages) scenario at the 35-year time horizon.

Cumulative portfolio losses are highest under a Transformation scenario where they exceed 3% and 6% at the 10- and 35-year time horizons. Cumulative losses accelerate fastest under the Fragmentation (Higher Damages) scenario between 2025 and 2050 rising from 1% to 4%. If our analysis was extended beyond 2050 the Fragmentation scenarios would likely become the most negative as the economic influence of the R and I risk factors is expected by most IAMs to increase dramatically in the latter half of this century.

Figure 15: Climate change impact on CalSTRS' total portfolio by scenario
Cumulative and Annualized Median Return Impact over 10 Years and 35 Years



INDUSTRY SECTOR IMPLICATIONS

Consistent with the findings in the public report, the impact on different sectors varies widely. This can result in significant variations within equity portfolios. Compared to various custom benchmarks in each regional active equity portfolio – US, Developed ex Emerging Market (EM) and EM – managers tilt away from Financials. On a region-specific basis CalSTRS' Emerging Market (EM) active equity managers have a strong bias towards the Information Technology (IT) sector and away from the Materials sector. In international developed active manager portfolios exposure tilts toward IT and away from Consumer Staples versus the custom benchmark. In US active equity sector weights are largely in line with the custom benchmark excepting the aforementioned Financials bias across the board.

Figure 16: CalSTRS active equity sector weights versus custom benchmark

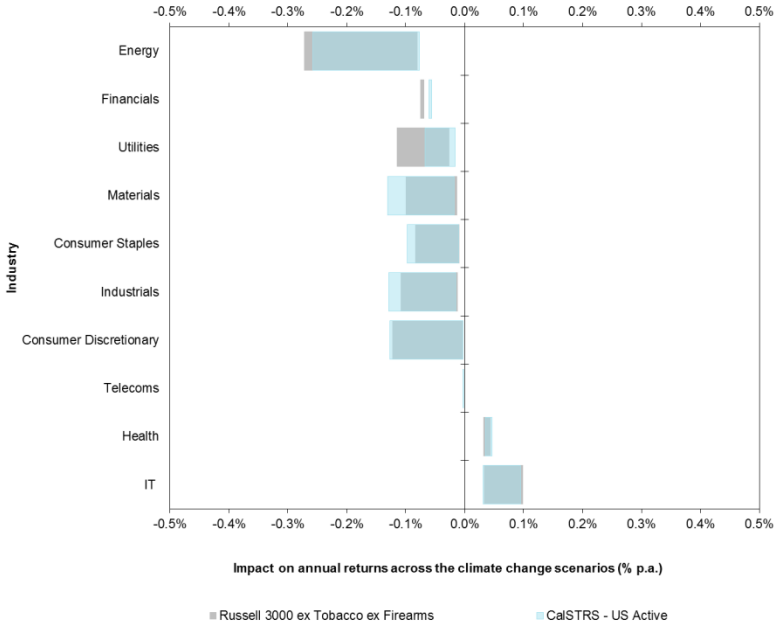
Industry Sector (%)	U.S. Active			Non - U.S. Active ex EM			Non - U.S. Active EM		
	Port.	Bench.	Diff.	Port.	Bench.	Diff.	Port.	Bench.	Diff.
Financials	14.67	18.18	-3.51	24.60	27.65	-3.05	27.50	30.83	-3.33
Information Technology	18.38	19.20	-0.81	8.74	4.57	4.17	25.69	18.30	7.40
Consumer Discretionary	13.88	13.36	0.52	13.67	12.78	0.90	12.24	9.22	3.03
Consumer Staples	8.33	7.13	1.20	6.39	9.16	-2.77	8.05	7.70	0.36
Telecoms	1.87	2.06	-0.18	4.92	4.70	0.22	7.25	7.56	-0.31
Industrials	13.09	10.99	2.11	14.59	12.36	2.24	6.14	6.97	-0.83
Energy	6.94	7.30	-0.37	5.35	6.66	-1.31	5.11	6.55	-1.43
Materials	4.61	3.51	1.10	7.05	7.73	-0.68	3.97	7.00	-3.03
Utilities	1.72	2.91	-1.19	2.43	3.46	-1.03	2.85	3.27	-0.42
Health Care	16.49	15.36	1.14	12.26	10.94	1.32	1.18	2.61	-1.43
Total	**100.00**	**100.00**	**0.00**	**100.00**	**100.00**	**0.00**	**100.00**	**100.00**	**0.00**

Holdings Data As Of:
U.S. Active 8/08/2014
Non - U.S. Active ex Emerging Markets 6/30/2015
Non - U.S. Active Emerging Markets 6/30/2015
Benchmark Data As Of:
US: CalSTRS Russell 3000 ex Tobacco ex Firearms 6/30/2015 (Discontinued as of 07/30/2015)
Non-US ex EM: CalSTRS MSCI EAFE + Canada ex Tobacco ex Firearms Index 6/30/2015
Non-US EM: CalSTRS MSCI EM ex Tobacco ex Firearms 6/30/2015

To demonstrate the impact of these sector bets in active portfolios the charts below have been structured to show the median annualized return impact over both 10 and 35 years. The bars reflect the climate return impact at the sector level times the weighting for each industry sector across the four modeled scenarios as a means of attributing climate change risk to each. CalSTRS' allocations are represented in light blue and benchmarks in grey. Blue bars extending to the left of grey bars indicate more sector-level climate change risk in the active allocation than the benchmark and vice versa. Analysis of these charts is offered alongside the following figures.

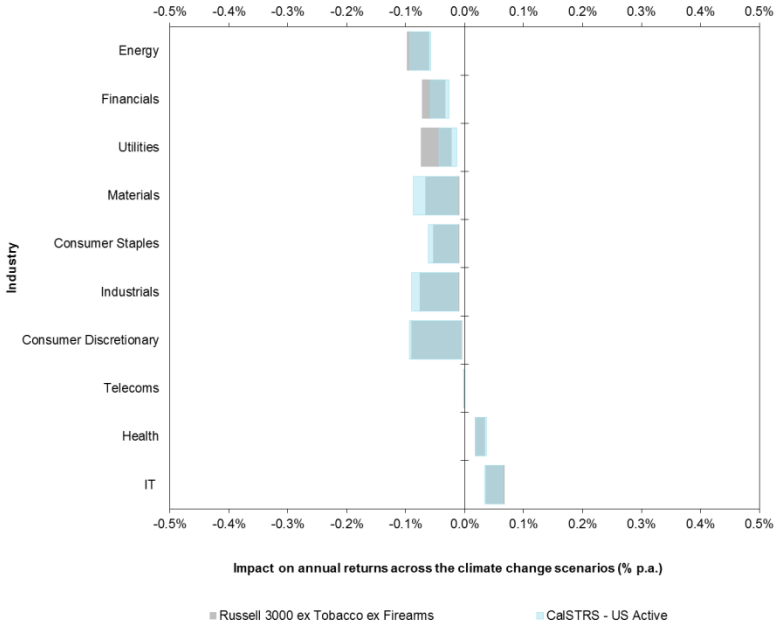
Figure 17: Active US equities: industry sector analysis
Median annual return impact over 10 years (to 2025) and 35 years (to 2050)

10 years



As a group, CalSTRS' active US equity managers are largely in line with the index in terms of their exposure to climate sensitive sectors. Though the slight underweight to utilities translates to a smaller and shallower impact range for expected losses in that sector.

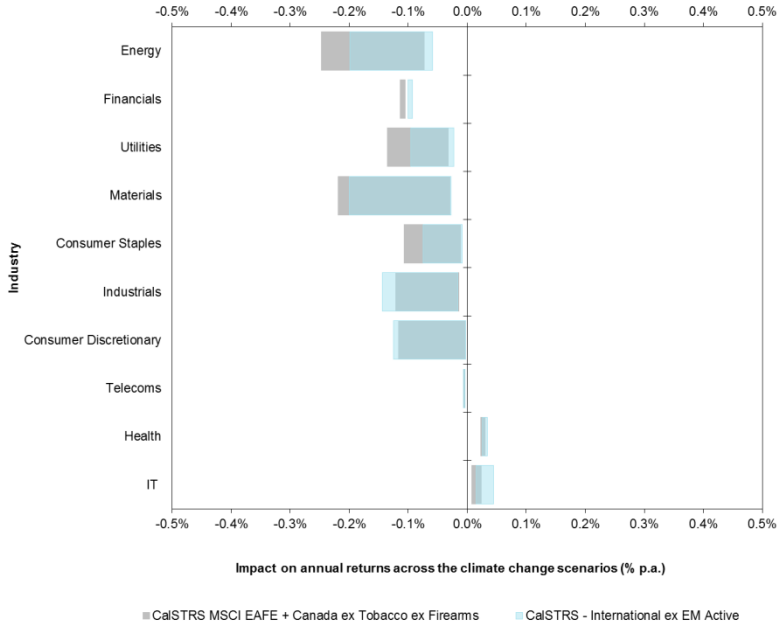
35 years



The potential sector impacts narrow over the 35-year time period. CalSTRS should continue its efforts to ensure its active US equity managers understand the implications of climate risk on their holdings and position their sector exposures accordingly.

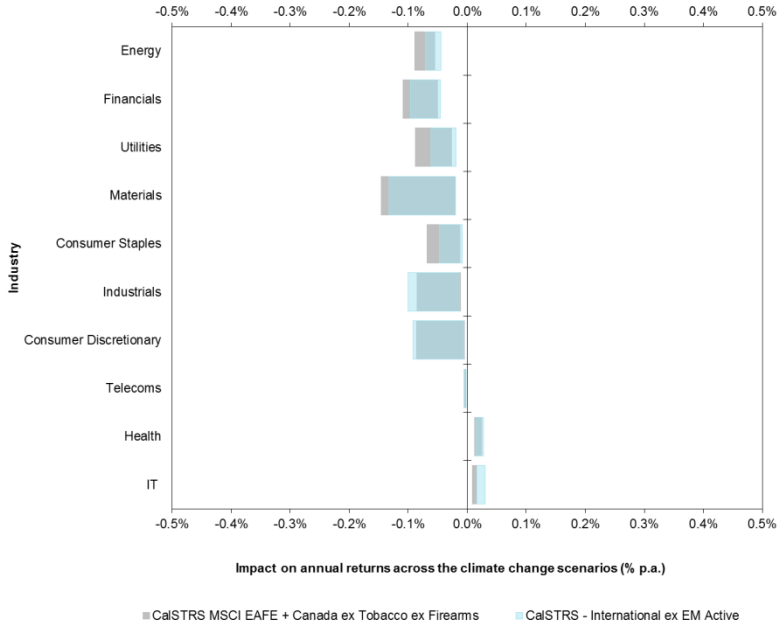
Figure 18: Active international ex emerging market equities: industry sector analysis
Median annual return impact over 10 years (to 2025) and 35 years (to 2050)

10 years



CalSTRS' active International ex EM equity managers have slightly less exposure to some of the more climate-sensitive sectors including Energy, Utilities and Materials. It would be useful to engage with managers to understand the reasoning behind these biases to see if they are structural or simply a temporary function of market dynamics.

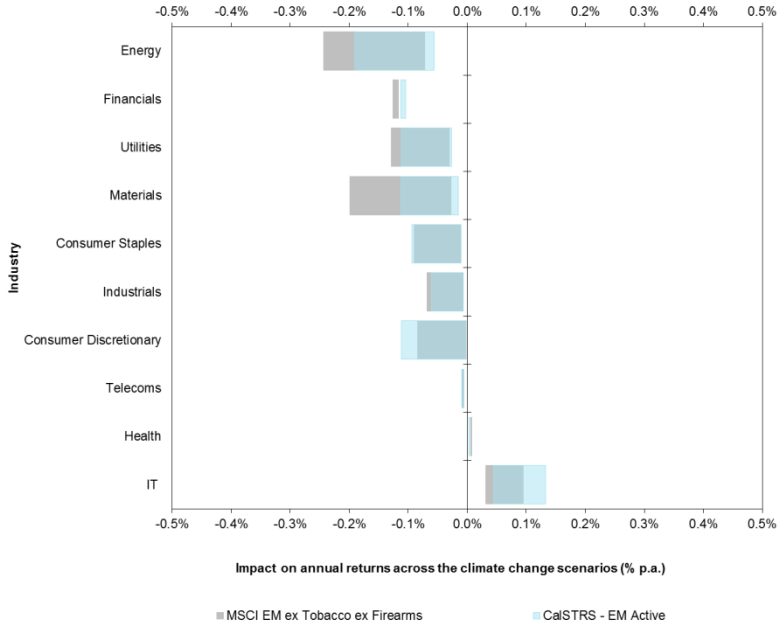
35 years



The potential sector impacts narrow over the 35-year time period. CalSTRS should continue its efforts to ensure its active International ex EM equity managers understand the implications of climate risk on their holdings and position their sector exposures accordingly.

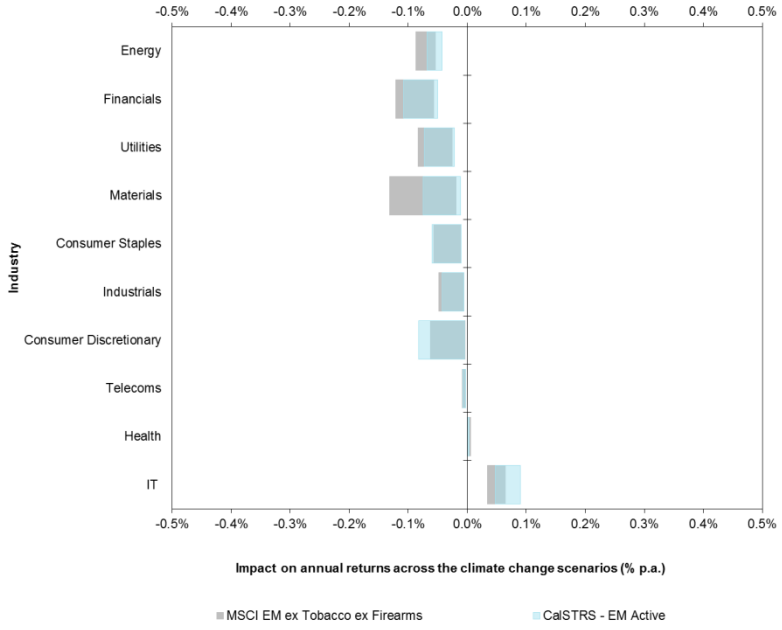
Figure 19: Active emerging market equities: industry sector analysis
Median annual return impact over 10 years (to 2025) and 35 years (to 2050)

10 years



CalSTRS active Emerging Market equity managers exhibit some of the same sector-level biases as CalSTRS' active International ex EM managers though somewhat more pronounced in the Energy and Materials sectors. Other sector exposures are broadly in line with the index.

35 years



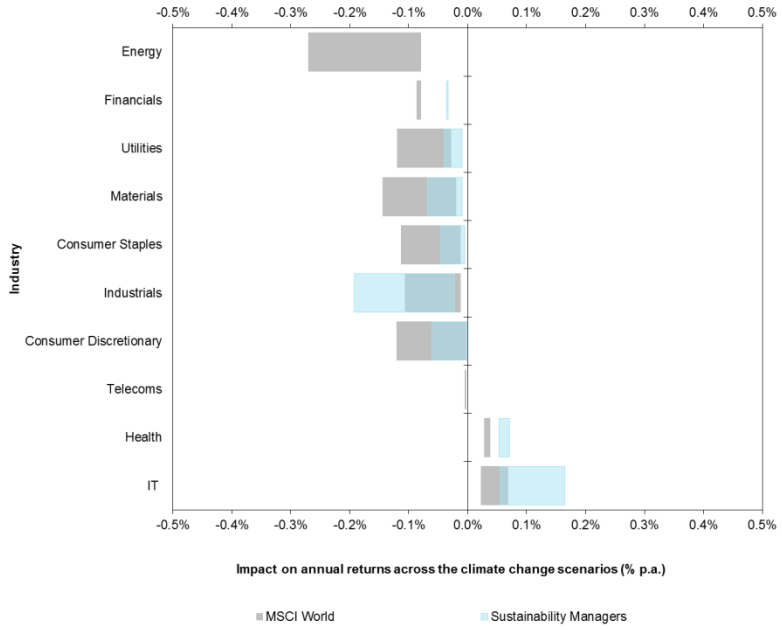
The potential sector impacts narrow over the 35-year time period but the underweight by active managers in the Materials sector continues to provide some protection against loss.

Sector exposure of sustainability-themed managers

For comparison purposes, the following charts display the sector exposure of a group of three global equity sustainability-oriented managers versus the MSCI World. As is apparent, the climate sensitivity of the combined sector weights of these managers is lower than the benchmark. This helps to demonstrate the potentially positive influence that the addition of one or more sustainability-oriented managers could have on the overall sector profile of CalSTRS' active global equity exposure.

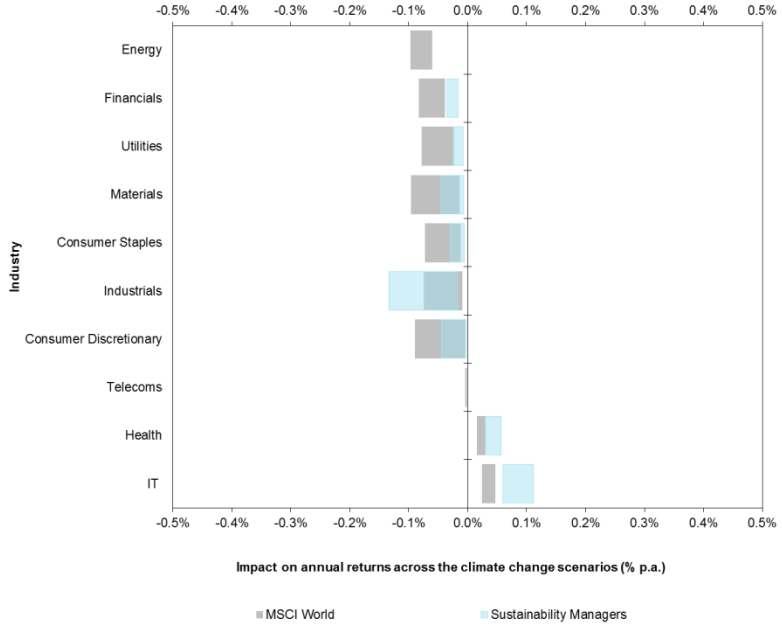
Figure 20: Sample sector profile of three sustainability-themed global equity managers versus MSCI World

10 years



As is apparent, this group of sustainability themed global equity managers have lower exposure to the sectors that are expected to be the most neagtively impacted by climate change: notably Energy and Utilities. .

35 years



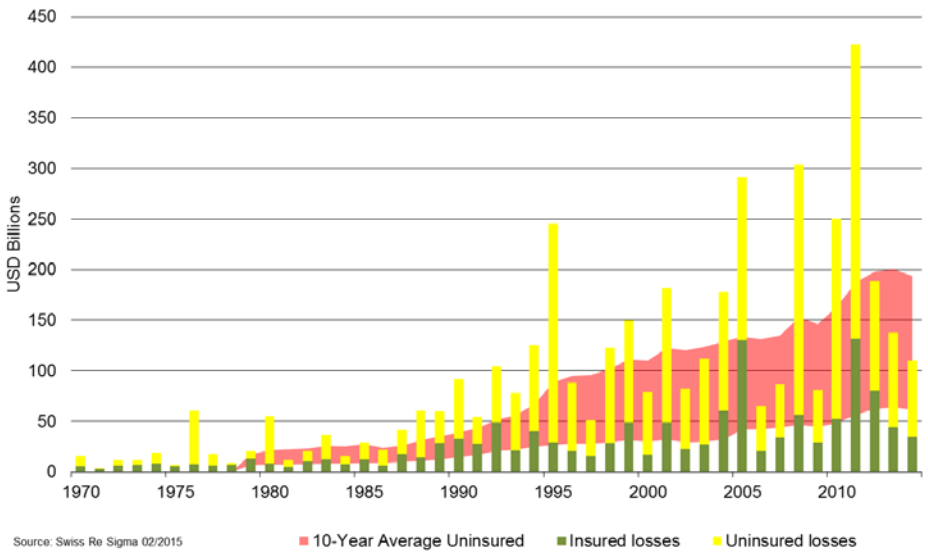
The sustainability themed managers have more exposure to IT and Industrials, wherein stock selection tends to focus on companies providing solutions to the low-carbon eocnomy (e.g. cleantech).

Real Estate and Real Asset Investments – Supplementary Asset Allocation Detail

Real Estate and Real Asset investments, including Agriculture, Timber and Infrastructure, offer investors a variety of attractive attributes, such as a higher return profile than typical fixed income options and a relatively low correlation to broader fixed income and equity markets. They also stand to gain from climate policy action and related technological investment flows. However, by virtue of their direct and tangible exposure to the physical manifestations of climate change (short- and long-term weather shifts), the vulnerability of real asset exposures to higher temperature outcomes (e.g. our Fragmentation scenarios) are relatively high versus other asset classes. This is exacerbated by a widening gap in catastrophe un(der)insurance (see Figure 20) and a growing concentration of exposure in coastal cities due to demographic trends.

Such push and pull between climate risk factors results in large return variability across climate scenarios for Real Estate and Real Assets as depicted by the positive influence of the climate risk factors on all such subclasses under the Transformation scenario and detraction of returns under the Fragmentation scenarios (see portfolio circle charts above and Figure 11). This range of outcomes demonstrates a greater need for monitoring of such tangible exposures at the portfolio level to ensure climate change risks – which are in this case largely location dependent – are being monitored and managed. Moreover, since many such assets are typically held for long tenors, an assessment of their exposure to long-term risks such as climate change should be incorporated at the time of investment origination as well as ongoing.

Figure 21: Worldwide Uninsured Catastrophe Losses – A Widening Gap



As shown here, the gap between economic and insured losses is widening. Monitoring portfolios for overall exposure to extreme risks and ensuring adequate catastrophe insurance coverages are in place should be a priority for investors in real assets going forward.

The manner and method of monitoring these exposures and related protections will differ depending on the manner and method of Real Estate and Real Asset investment utilized (e.g.

direct investment vs. outsourcing to a fund manager and listed public vs. unlisted private exposures). These asset classes and related methods of exposure access differ insofar as they have different liquidity and risk/return profiles. The turnover of investments underlying third-party funds is also important. At CalSTRS Real Estate and Real Asset exposures are held in a mixture of vehicles:

Figure 22: CalSTRS real estate and infrastructure exposures by vehicle type

CalSTRS Real Estate and Real Asset Exposures by Vehicle Type[7]		Allocation
Real Estate	Joint Ventures and Separate Accounts	7.40%
	Funds (Closed & Open-Ended) / Co-Investments	5.60%
Infra-structure	Closed End Funds	1.72%
	Open End Funds	1.25%
	Direct/Co-Investments	0.20%
	Public Securities	0.56%
Total		**16.73%**

- **Real Estate**
  - **Joint Ventures and Separate Accounts (Direct)**: The largest portion of CalSTRS Real Estate portfolio is invested directly in properties through Joint Ventures and/or Separate Accounts which function effectively as direct investments by CalSTRS into assets. These approaches generally require a long-term buy-and-hold strategy to realize target gains both from rental income and value appreciation. For assets acquired in these fashions, exposure to climate change is highly location dependent. To appropriately understand the climate change risk profile of these assets, location-level information is necessary and can be used to analyze geographic exposure characteristics and/or to calculate probabilistic exposure to weather/catastrophe risk (of an asset or the whole portfolio).
  - **Funds and Co-Investments (Comingled)**: The next largest vehicle types used in CalSTRS' Real Estate portfolio are comingled (typically closed-end) funds and co-investments (typically done in conjunction with a closed-end manager). Such investments are likely to be relatively illiquid when compared to most other forms of Real Estate investment. This illiquidity profile makes understanding the climate change-related risks of these investments all the more important. To understand such risk, collecting information regarding the prospective building and geographic profile of a new fund is essential. It is also important when entering

[7] Percentage allocations by vehicle type are derived from actual allocations to these asset classes as of June, 2015 and applied as a pro rata portion of the strategic asset allocation to each asset class cited elsewhere in this report. Some uncertainty remains around ultimate vehicle type mix once full strategic asset allocation is realized in the infrastructure asset class in particular.

such an investment to understand how managers are evaluating TRIP factor risks as part of their ESG and investment analysis process. As funds begin to be deployed it becomes important to understand the actual realized geographic exposure profile of each fund and of all CalSTRS' fund holdings in aggregate if possible.

- **Infrastructure**: As CalSTRS continues to realize its strategic allocation to Infrastructure it will be important for CalSTRS to monitor and manage the geographic profile of its portfolio and to ensure adequate diversity of exposures when it comes to their climate resilience. The characteristics of each investment which may otherwise indicate climate sensitivity (e.g. weather or water sensitive energy production) should also be monitored in conjunction with the liquidity profile of such investments which can vary depending on the means of accessing such exposure.

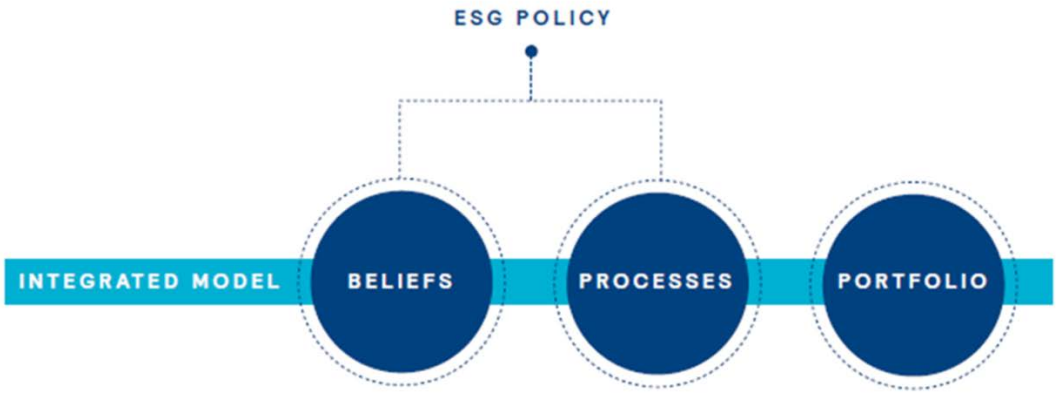
CalSTRS has already made significant strides toward assessing the physical risk of its Real Estate portfolio through its relationship with an insurance broker which provides CalSTRS with annual assessments of natural disaster risk in its directly acquired and insured portfolio. CalSTRS is also looking at sea-level rise and water availability is also being considered for evaluation. To the extent possible we encourage the extension of this growing rigor in catastrophe, weather and resource risk assessment to all Real Estate and Real Asset holdings whether internally or externally managed so as to develop a holistic view of portfolio climate change risk.

3

RECOMMENDATIONS FOR CALSTRS

Consistent with a key finding of the public report, our CalSTRS-specific findings suggest that climate risk is inevitable but outcomes can be improved by being prepared. Addressing climate risk within portfolio decisions is most effective when it is integrated within standard investment decision-making processes. This is consistent with Mercer's recommended approach to incorporating broader environmental, social, and governance (ESG) considerations into investment processes (Figure 22).

Figure 23: Integrated Model for Addressing ESG Considerations



Source: Mercer[8]

RECOMMENDATIONS AND NEXT STEPS

The following sections outline our recommendations for CalSTRS based on the actions it has undertaken to date. Ongoing and future actions have been categorized in line with the above framework – Beliefs, Policy, Process and Portfolio. We have organized our summary of recommended actions immediately following into two categories – Objectives and Tasks. The former include *general* aspirations to support CalSTRS' overall strategic portfolio management of climate change risk. The second are *specific* short-term tasks which the various teams within CalSTRS can undertake to evolve CalSTRS' strategic approach to climate change risk management and opportunity capture.

[8] Mercer. An Investment Framework for Sustainable Growth, 2014, available at: http://www.mercer.com/services/investments/investment-opportunities/responsible-investment.html..

Objectives

- **Develop a "house view" of climate change risk** based on the results of this study and other climate risk assessment efforts underway or being contemplated. The scenario or combination of scenarios used for planning purposes will influence risk management decisions and help to determine CalSTRS' desired role as a Future Taker or Future Maker[9]. The recent Paris Agreement (which reflects the ambitions of our Transformation scenario) is a relevant consideration in this regard.
- Continue to collaborate across departments and asset classes to **embed climate change risk management practices throughout the organization**.
- **Develop a holistic climate change risk management strategy** which reflects house view of risk and outlines a work plan for future one-time and ongoing activities, and related monitoring and reporting.
- **Address resourcing needs** to ensure appropriate execution of climate change strategy.

Tasks

- **Finalize investment beliefs** at board level and ensure inclusion of appropriate references to ESG and climate change risk/opportunity.
- **Initiate a review of the 21 ESG Risk Factors** and approach to ESG investing currently outlined in the Investment Policy and Management Plan to ensure compliance with CalSTRS current practices and industry best practices.
- **Risk assessment and monitoring:**
    - **Integrate ESG risk assessments** in portfolio risk management and manager selection/monitoring.
    - **Undertake environmental and climate resilience assessment** of all Real Estate and Real Asset holdings (directly, or in conjunction with managers/third-parties).
    - **Continue to work across departments** aligning the ESG risk assessments already conducted by the Corporate Governance team with financial risk assessments conducted by the Risk Management team.
- **Portfolio construction**:
    - **Equities**: With close to a 60% allocation to Public and Private Equity and with a decidedly developed-world focus, CalSTRS has a significant exposure to climate policy action as contemplated under the Transformation scenario. If CalSTRS believes a Transformation outcome or similar is likely in the near term (e.g. next five years) CalSTRS should consider diminishing this exposure in one or multiple of the following ways:
        - **Regional Equities**: Consider diversifying regional exposure to include more Emerging Market Equities (at least in line with global benchmarks) keeping in mind other macro factors influencing the attractiveness of the region while possibly diminishing exposure to US/Developed Market Equities.

[9] http://www.brinknews.com/the-future-makers-long-term-investors-as-climate-change-cops/

        - **Active equities**: Consider adding more thematic sustainability manager(s) to the global equity mix and/or other means of managing sector exposures within equity allocations.
        - **Passive Equities**: Continue efforts to reallocate a portion of passive equity holdings to alternatives (e.g. low-carbon tilted strategies) which may offer climate policy protection.
        - **Private Equity**: Consider further allocations to emerging market or thematic strategies focused on sustainability.
    - **Real Assets**:
        - **Infrastructure**: Consider a larger allocation to this asset class with a focus on green/resilient infrastructure.
        - **Timber and Agriculture**: Explore the possibility of strategic allocations to these asset classes with a focus on sustainable forestry/farming assets.

Summary of Current Activities

CalSTRS has incorporated a number of sustainability concepts into its organizational Vision and Guiding Beliefs which follow:

Vision
"CalSTRS advances sustainability practices that promote long-term value creation, responsible investment strategies, stewardship of our natural resources and engagement with our stakeholder community."

Guiding Beliefs
The purpose of our guiding beliefs is to shape our organization's environmental, social and governance actions and interactions with our stakeholders.

1. *CalSTRS supports sustainability programs that build environmental, social, and governance principles into our core business and investment practices.*
2. *CalSTRS responsibly manages risk for the long-term financial strength of CalSTRS, to the benefit of our members, stakeholders, and the environment.*
3. *CalSTRS engages with our stakeholders, business partners and our community on environmental, social and governance issues and principles to understand their insights and perspective.*
4. *CalSTRS considers the global impact of our business practices in the use of natural resources within our facilities and through the procurement of goods and services.*
5. *All CalSTRS investments should seek to responsibly manage and disclose economic, social, and environmental criteria in order to deliver sustainable and profitable, risk-adjusted returns.*
6. *CalSTRS encourages procurement of goods and services with contractors and supply chain vendors who incorporate sustainability and environmental, social, and governance criteria into their business practices.*
7. *CalSTRS believes in providing a supportive work environment where employees are encouraged to develop and achieve their full career potential.*
8. *CalSTRS discloses material sustainability issues and sustainable performance data.*

These guiding beliefs were developed as part of a staff process which did not involve the CalSTRS board or investment committee. Therefore they are not considered "investment beliefs and are not directly relevant to CalSTRS' investment process. They nevertheless express the culture of the organization. Moreover belief statements are incorporated throughout CalSTRS investment documentation[10] and underscore CalSTRS' extensive work in responsible investment to date.

As respects the investment process, CalSTRS has laid out the following ESG procedures in its Investment Policy and Management Plan (IPMP):

> **Environmental, Social and Governance Risks, ESG –** CalSTRS Investment Portfolio operates in a unique and complex social-economic milieu, and the Board expects its staff and investment managers to select investments after a careful investigation and deliberation of the risks versus the potential return. To assist staff and investment managers, the Board has promulgated a partial list of risks to be considered that are of particular concern to CalSTRS. This list and the ESG Policy are included as Attachment A to this policy [Investment Policy for Mitigating Environmental, Social, and Governance Risks (ESG)].

Attachment A to the IPMP focuses on social and governance risks and outlines a process by which CalSTRS will engage with managers/companies on ESG issues. It also includes a list of 21 ESG Risk Factors of particular concern to CalSTRS. Of these factors only one is explicitly/directly relevant to climate change:

> **Environmental**
> The investment's long-term profitability from activities and exposure to environmental matters such as; depleting or reducing air quality, water quality, land protection and usage, without regard for remediation. Consideration should be given to how a company is dealing with the impact of climate change, including whether the government is taking steps to reduce its impact, exacerbating the problem, or oblivious to the risk.

In CalSTRS' Strategic Plan for the 2012-17 fiscal years a series of goals and objectives are laid out including the following:

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[10] E.g. clause G of CalSTRS' Corporate Governance Principles says "CalSTRS believes that environmental, social and governance (ESG) issues can affect the performance of our investments. CalSTRS believes it is important for companies to consider ESG issues to ensure they are long-term sustainable companies and have considered and addressed all risks that could affect the livelihood of the business." This is redoubled in Appendix A of the same document: "…we believe that environmental, social, and corporate governance (ESG) issues affect the performance of the investment portfolio to varying degrees across companies, sectors, regions, asset classes and through time. CalSTRS is a large investor and as such, is in a position to exert influence on the corporations in which it has invested. Therefore, CalSTRS will actively analyze and exercise its ownership rights in all markets in order to act in a responsible manner to its beneficiaries across multiple generations."

Goal 2: Risk Management – Objective D

Demonstrate the value of integrating environmental, social and governance opportunities into CalSTRS' culture and strategies:

1. Engage stakeholders on sustainability policies and expectations. (July 2013–15)
2. Establish an internal planning and reporting framework using Global Reporting Initiative principles. (July 2013–17)
3. Continue to integrate environmental, social and governance factors into internal and investment operations, and across the entire investment portfolio. (July 2012–17)

In line with the abovementioned policy language and strategic plan CalSTRS conducts/has conducted a number of sustainable investment activities which are relevant to climate change risk management at the portfolio, manager and company levels. A summary of relevant sustainable investing activities to date follows with an emphasis on those related to climate change or the environment. These activities have been separated into two broad categories:

Figure 24: CalSTRS Current Sustainable Investment and Active Ownership Activities

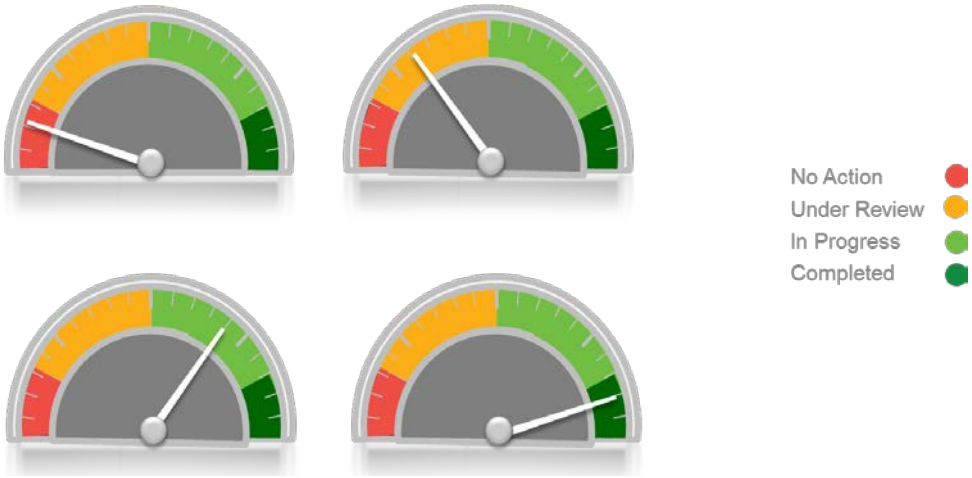
Sustainable Investment	Active Ownership
• Overall investment philosophy emphasizes "Long Term Patient Capital" which aligns naturally with consideration of long-term systemic risks such as climate change. • Investment Policy Mitigating Environmental Social and Governance and Risks (Attachment A) to IPMP identifies 21 ESG risks that should be reviewed for any investment in any asset class or region including "Environmental" risk. • Divestment Policy emphasizes engagement over selling controversial positions and is currently being activated as a result of a State of California legislative decision to divest public pensions from thermal coal. • Staff established the "21 Risk Factor Review Committee" to evaluate exposure to ESG-related risks and take appropriate actions. • The Green Initiative Task Force reports annually on environmental investment initiatives and investments. A list of notable transactions and portfolio achievements follows for the period ending June 30, 2015: o Global Equities Sustainable Investment Program includes allocations to: AGF Investments; Generation Asset Management and; New Amsterdam Partners. o 45% of Fixed Income investments are in Barclays MSCI US AGG Sustainability Index and $264M of	• Corporate Governance Principles incorporate many sustainability themes in its Statement of Shareowner ESG Responsibility. On environmental matters, CalSTRS typically votes in favour of proposals designed to limit carbon emissions or to prevent environmental degradation by holding companies. • CalSTRS proxy voting history demonstrates the organization's commitment to company sustainability issues and includes: o Collaborative efforts with INCR and PRI on carbon risk and fracking respectively engaging with over 100 companies on these subjects in 2014-15. o Since 2008, CalSTRS has filed 41 environmental- related shareholder proposals that called on companies to improve their environmental risk-management disclosure efforts. o Engagement letters were sent in 2014-15 to 14 REITs to encourage greater disclosure of their energy efficiency efforts. • ESG considerations are incorporated variously across asset classes in asset/manager selection and monitoring procedures including in Global Equity where three climate-change-specific questions are asked of existing managers each year.

the portfolio is in Green Bonds. o Some of the Real Estate funds in which CalSTRS has invested focus on energy efficiency in holdings; in separate account Real Estate investments CalSTRS implemented a Sustainable Returns Program which focuses on improving energy efficiency and LEED profile of owned buildings. o Some Infrastructure funds have renewable power generation projects in their portfolios. o $693M of Private Equity investments in cleantech and renewables. • ESG investment options have been added to Pension2 (CalSTRS DC Plan).	• Executive-level involvement with CDP, PRI, SASB and CERES/INCR and involvement by Corporate Governance team in CII, ICGN and ACGA.

Climate Actions Table

To highlight focus areas for future resource allocations by CalSTRS we have assigned progress/advancement indicators for each activity type in Figure 21 below. These indicators align with the following scale:

Figure 25: Climate Action Progress Indicator



Progress against best practices has been determined based upon Mercer's industry knowledge and the actions of other Study partners with respect to climate change and related investment implications. Information regarding the status of CalSTRS' current activities was obtained through interviews with CalSTRS staff and a review of literature in the public domain and/or provided to us directly by CalSTRS staff.

Figure 26: Detailed recommendations for management of climate change risk

Actions Categorized within the Mercer Framework for Sustainable Growth

Framework Step		Total Portfolio
1.BELIEFS	**Investment Beliefs**	**Status**: CalSTRS currently does not have a formal set of investment beliefs which articulate its position with respect to ESG investment or climate change in particular. However, some formalized documents do contain sustainable investment belief statements and the organization has developed a set of "Guiding Beliefs" through a staff-driven process as well as a subcommittee of the Board. Additionally the organization has signed the PRI which entails alignment with certain beliefs-like statements. **Recommendation**: CalSTRS should endeavor to build on the work it has already conducted to adopt at board level a formal set of sustainable investment beliefs (within or apart from a broader set of investment beliefs) which articulate CalSTRS' outlook regarding climate risk and opportunity in the context of industry best practice, fiduciary duty, and stakeholder expectations. CalSTRS should consider initiating this process with a comprehensive board sustainable investment education program and should solicit broad-based input during the beliefs development process to ensure any such statements are adequately socialized prior to being finalized. A draft set of beliefs could be cobbled together in part drawing from statements in existing documentation and based on work already conducted (e.g. sustainable investment governance project which resulted in the formation of a subcommittee of the CalSTRS Board). It should be noted that the lack of a written sustainable investment beliefs statement has not hindered the progression of various sustainable investing initiatives within CalSTRS to date, though formalization of sustainable investment beliefs could serve to support a System-wide strategic approach to such efforts (see following sections of this table for more detail).
2. POLICIES	**Investment Policies**	**Status**: CalSTRS' IPMP lays out broadly the rules of engagement for ESG matters during the investment process and also contains a list of 21 ESG Risk Factors which are to be considered by CalSTRS staff and outsourced investment managers in all investment decisions. Of these 21 risk factors only one pertains to environmental risk/climate change. In its Corporate Governance Principles – Appendix A Statement of Shareowner ESG Responsibility – CalSTRS' approach to addressing ESG issues through active ownership is made clear as is its stance with respect to social injuries caused by environmental damage and climate change. **Recommendation**: While CalSTRS' current actions already demonstrate a commitment to ESG integration and climate risk management, moving forward we encourage CalSTRS to consider revisiting its 21 ESG Risk Factors to ensure they are comprehensive and reflect the best current thinking on the materiality of ESG factors (e.g. SASB). These factors might also be quantified and standardized to encourage consistent and actionable reporting on ESG matters by investment managers and CalSTRS staff.

3. PROCESSES	**Portfolio Specific** 	**Status**: CalSTRS integrates ESG considerations throughout the process of manager selection and monitoring and in its direct investments. CalSTRS expects all investment managers, both internal and external to assess the 21 ESG Risk Factors when making any investment decision. In monitoring active investments, for the last five years CalSTRS has polled existing global equity managers on their approach to climate change, now asking the following three relevant questions: 1. Do you explicitly incorporate climate risk into your investment process? 2. Is climate change a primary factor? 3. Have you taken steps to better incorporate climate risk into your investment process since last year? The qualitative answers to these questions provide some useful information for the assessment of manager progress with respect to a key ESG issue. **Recommendation**: Along with revisiting and revising the 21 risk factors as per the preceding recommendation, we would encourage more systematic assessment of ESG risks and opportunities (including those related to climate change) in investment decisions at all levels (portfolio, asset class, fund, asset) and pre- and post-acquisition. Embedding distinct quantitative metrics into investment management processes – where possible, practicable and material – would more readily enable periodic progress reviews and improve the quality/consistency of ESG due diligence/monitoring. To provide further support to individual asset class portfolio managers an ESG research function could be centralized within the Corporate Governance team and/or disaggregated amongst asset class teams starting with Public Equity where ESG data and tools are more advanced and moving towards other asset classes in future. As respects climate change in particular related risk assessment should be integrated into portfolio risk management and manager selection and monitoring again using quantitative data where possible (e.g. carbon footprint; ESG index scores). Developing a consistent framework for climate risk assessment and opportunity identification will also serve to facilitate data collection, reporting and communication of related progress to stakeholders (e.g. in future Green Initiative Task Force reports).
	Systemic (Market-Wide) 	**Status**: CalSTRS is well represented at industry forums and membership groups including: UN PRI (a signatory); Ceres and INCR; GRI and; CDP members and signatories. CalSTRS also does well to leverage these networks to the benefit of the retirement system's members by signing onto industry/regulatory letters proposed/drafted by these groups and cosigning resolutions where issues align with CalSTRS priorities. **Recommendation**: Continue to encourage mandatory company reporting on climate risk and related ESG metrics. Also consider engaging (supra)national bodies to encourage regulations that enable capital to flow easily into climate mitigation and adaptation as well as appropriate valuation of natural capital (aka ecosystem services). Addressing regulatory barriers to increased investment in green infrastructure might also be a focus.

4. PORTFOLIO	**Risk Assessment** 	**Status**: Completion of this tailored report represents a significant step toward best-practices assessment of climate risk. CalSTRS has also received some carbon footprinting analytics from external data providers for CalSTRS' global equities portfolio. CalSTRS also has access to ESG data on public equity holdings from a number of external data providers which are accessed periodically in helping to inform its engagement strategy, but are not presently widely used by asset class teams to determine the ESG caliber of various investments. **Recommendation**: After digesting the implications of this report CalSTRS should consider how best to incorporate its findings into portfolio risk management considerations. CalSTRS should also conduct additional portfolio, asset class and/or strategy-level assessments of ESG risk where possible using already accessible data with a particular view toward the environmental profile of its investments. Such assessments should be feasible, with varying degrees of data penetration and granularity, in Public Equity, Private Equity, Fixed Income, Real Estate and Real Assets. As respects the latter two, we encourage CalSTRS' ongoing effort to assess the geographic exposure profile of its direct/JV investments in Real Estate and Real Asset classes and Private Equity (where CalSTRS' stake is controlling and insurance procurement can be influenced) as these risks are highly susceptible to the physical impacts of climate change and the presence/price of adequate insurance given their underlying physical exposure characteristics. CalSTRS Fixed Income team should also endeavor to understand the efforts of credit rating agencies to address climate change risk in their assessments of debt issuers. CalSTRS should also review existing manager approaches in asset classes other than Public Equity to ensure climate-risk analysis is integrated into their processes. This can be supplemented by possible holdings-level and strategy-level analysis using external research provider data.

	Risk Reduction, Transfer, Hedging 	**Status**: CalSTRS Global Equity team is in the process of developing an alternative indexing platform to test the merits of various dynamic or smart beta approaches including low-carbon tilting. **Recommendation**: Rebalance/reallocate and adapt portfolios to reduce downside in accordance with the organization's own view of climate change risk as developed coming out of this study. For passively managed strategies this could involve tilting away from carbon-intensive assets using low-carbon index-linked funds, other smart beta approaches or even exclusionary techniques (e.g. ex Thermal Coal). For actively managed strategies, ESG integrated funds, broad sustainability oriented funds or thematic funds (e.g. water, renewables, agriculture) all could offer potential downside protection against climate risk as well as related opportunity capture. Some investors have also adopted synthetic hedging strategies using derivatives[11]. To govern the use of such alternative investment approaches, it may be helpful to consider portfolio-level targets (e.g. level of decarbonisation or level of sector exposures), and reinforce these portfolio actions with related engagement actions. Going forward CalSTRS should show preference for managers that integrate climate analysis and active ownership in their investment process. More due diligence related to these various alternative climate risk management approaches and how they might fit into CalSTRS' portfolio should be explored subject to available research and resources.
	Identify Opportunities 	**Status**: Through its Green Initiative Taskforce CalSTRS has identified and invested in a variety of opportunities across asset classes which look to capitalize upon trends in sustainability and climate change. These are enumerated in Figure 22. **Recommendation**: Beyond the current investments being made with a view towards environmental upside, CalSTRS has an opportunity to develop a strategic total-fund approach to the identification and vetting of sustainable investment opportunities across asset classes and to monitoring them once they are in the portfolio. Defining a total portfolio approach to sustainable investing – including what criteria constitute a sustainable investment – and allocating strategic capital to such opportunities would be useful toward enabling portfolio ESG and climate change risk management practices. Opportunities arising from climate change fall broadly across asset classes into both mitigation (green) and adaptation (resilience) themes. CalSTRS has a solid portfolio of green investments already but their role in CalSTRS' overall asset allocation framework could be clarified (e.g. whether they are positioned for risk management, opportunity capture or both). Additional effort could also be made to engage in climate resilience investing, perhaps with a focus on alleviating California's specific potential vulnerabilities (e.g. water). This could entail strategies across asset classes that invest in resilient/sustainable infrastructure development/management, sustainable real estate, companies financing climate risk transfer innovation (e.g. ILS/microinsurance), etc. CalSTRS should continue to explore passive Public Equity as well as Fixed Income (e.g. green bond indices) solutions and consider other methods of accessing and growing the Green Bond and other impact-oriented debt markets to the extent possible.

[11] For a discussion of one approach, see: http://www.corporateknights.com/channels/responsible-investing/make-killing-shorting-coal-companies-14279976/. In addition to the Total Return Swap discussed in this article investors have also successfully used weather/catastrophe derivatives to protect weather/catastrophe-sensitive investments (often in renewable energy), credit default swaps to protect debt holdings and carbon markets.

	Engage Investment Managers	**Status**: CalSTRS requires its investment managers across asset classes to adhere to its 21 ESG Risk Factors and related policy. CalSTRS also surveys equity managers with respect to their approach on climate change. **Recommendation**: CalSTRS should continue to ask its equity managers targeted questions with respect to ESG issues such as climate change. We suggest extending this questionnaire to other asset classes and supplementing these qualitative questions to the extent possible/practicable based on available resources with quantitative research leveraging ESG data which CalSTRS already has access to or may access in future. To the extent possible this ESG research should be standardized within and possibly across asset classes to allow for comparability of externally managed investment options.
	Engage Companies	**Status**: CalSTRS has comprehensive proxy voting guidelines and the Corporate Governance team works to set a shareholder engagement strategy annually (though with periodic revision throughout the year) using a variety of inputs including ESG data from third-party providers. Issue areas chosen for engagement are selected based primarily on stakeholder interest (e.g. board direction) and industry trends (e.g. climate change is a hot topic at the moment). Once issue areas have been identified CalSTRS quantifies its potential to wield influence (e.g. exposure and ownership %) to support prioritization of engagements within topic areas and sectors. **Recommendation**: Continue focusing engagement efforts towards greater disclosure of climate risk information and strategies by opaque companies. To improve the impact of engagement activities CalSTRS might consider a more strategic approach to issue identification based on broad stakeholder interest (e.g. a survey of key constituents). CalSTRS might also consider selecting/encouraging external managers based on their ability to engage on related issues to the extent not already being considered.

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APPENDIX A – Study Participants

Partners

- Allianz Climate Solutions GmbH – Germany
- Baillie Gifford & Company – UK
- BBC Pension Trust – UK
- British Telecom Pension Scheme (BTPS) – UK
- California State Teachers' Retirement System (CalSTRS) – US
- Church of England National Investing Bodies – UK
- Connecticut Pension Fund – US
- Construction and Building Industry Super (Cbus) – Australia
- Credit Suisse – US
- Environment Agency Pension Fund (EAPF) – UK
- Första AP-fonden (AP1) – Sweden
- Guardians of New Zealand Superannuation Fund (NZ Super) – New Zealand
- International Finance Corporation (IFC), a member of the World Bank Group – Global
- New York State Common Retirement Fund (NYSCRF) – US
- Queensland Investment Corporation (QIC) Limited – Australia
- State Super Financial Services (SSFS) – Australia
- The Department for International Development (DFID) – UK
- WWF-UK – UK

Advisory Group

- Dr Rob Bauer, University of Maastricht – Netherlands
- Dr Barbara Buchner, Climate Policy Initiative – Italy/Global
- Sagarika Chatterjee, Principles for Responsible Investment (PRI) – UK
- Paul Dickinson, Carbon Disclosure Project – UK
- Nathan Fabian, Investor Group on Climate Change – Australia/Global
- Mark Fulton, Carbon Tracker Initiative/ CERES/ Energy Transition Advisors – US/ Australia
- Dr Noah Kaufman, WRI (formerly NERA) – US
- Sean Kidney, Climate Bonds Initiative – UK / Global
- Bob Litterman, Financial Analyst Journal/ Asset Owners Disclosure Project – US
- Nick Robins, UN Environment Programme – UK
- Mike Wilkins, Standard & Poor’s Ratings Services – UK
- Dr Paul Wilson, RMS – UK
- Helene Winch, Low-carbon (formerly PRI) – UK

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APPENDIX C – Low-Carbon Indices

A number of low-carbon variants of broad market indices have become available over the recent past[12]. Benefits of these indices are that they are relatively straightforward and transparent (i.e. asset owners can point to a clear carbon reduction and impact) and inexpensive (albeit more expensive than broad market indices).

Beyond practical issues (such as cost, accessibility and performance), the key questions investors must consider is whether these indices will serve as downside protection in the face of rising carbon prices, and thus offer an effective hedge for passively managed equities. In a world where the cost of carbon is likely to rise then having less exposure to high carbon companies is intuitive, although it may not always be this straightforward. Two key points should be made here:

- A lower carbon footprint (including both current emissions as measured on CO2 emissions/sales and potential emission from fossil fuel reserves as measured on CO2 emissions/market cap), may not necessarily translate to lower operating cost (and thus relatively higher operating profits). Where demand is inelastic, suppliers may be able to push this cost to consumers, as may be the case for some utilities.
- Existing indices are based on Scope 1 and Scope 2 emissions (which cover direct emissions owned by the company and indirect emissions resulting from energy use by the company). In some cases, such as automotive, the critical measurement is actually Scope 3 (indirect emissions not owned by the company but related to the company's activities). Data on Scope 3 emissions is less prevalent, which may result in misrepresenting the actual net carbon benefit (or deficit) of a company. It should be noted that Scope 3 data is broadly available for the automotive sector and an improvement upon current indices could be to incorporate Scope 3 for this sub-sector.

Additional things to recognize about these indices are that:

- To date, they are based on market cap weighted methodology, and therefore bring with them the same concerns that core benchmarks have in this context (i.e. that investors end up with more exposure to overvalued companies as price fluctuates).
- They do not necessarily capture the opportunity side of the equation (i.e. by shifting from high carbon to lower carbon companies, investors may not necessarily gain exposure to companies leading on the development or provision of products/services best positioned to succeed in a lower carbon environment).
- Currently, index providers do not provide in-depth shareholder engagement on climate risk management as a supplement to index provision. This would be a welcome addition to the current offerings, and is likely to evolve based on client demand and feedback.

[12] Low-carbon versions of numerous indices are available from various large passive index providers.

Given the above considerations, low-carbon indices may not necessarily bring an outperformance premia in the traditional sense – i.e. the premia is low-carbon rather than performance. With a low tracking error to the benchmark, that should be ok; however clients should be aware that during periods of extreme stress or market dislocation that the performance of the low-carbon indices could deviate significantly from the mainstream benchmark. For example, during 2014 when oil prices declined significantly, low-carbon indices performed strongly relative to their parent indices; however, this performance could reverse during periods of strong energy sector performance and rebounding oil prices.

In closing, while low-carbon indices are not a perfect hedge against future uncertain carbon pricing, they do provide an interesting tool for long-term investors. We believe that CALSTRS should consider re-allocating some of its passive equities towards a low-carbon index variant, if it is aligned with one or more of the following statements:

a) We believe that action towards climate change mitigation will occur, resulting in some (meaningful) higher price on carbon over the coming 5 year period
b) We believe that climate change mitigation is beneficial to capital markets and System members over the medium to long run
c) Our stakeholders would like to see us clearly manage climate risk, both in our investments and through our actions as a financial sector stakeholder.

We would be pleased to discuss low-carbon index options in further detail with CalSTRS.

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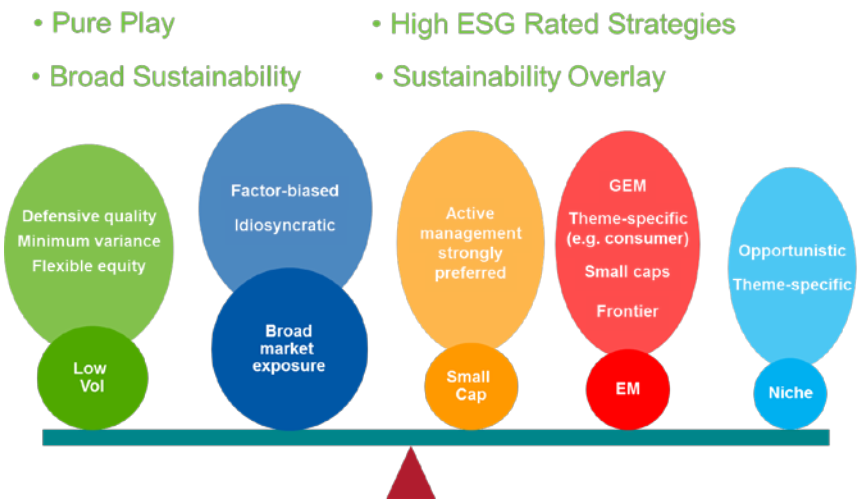
APPENDIX D – Thematic managers

The opportunity set within listed equity sustainability themes is primarily focused on: water (such as water infrastructure, technologies, and utilities); renewable energy and energy efficiency; food and agriculture; and broad sustainability, capturing some or all of the aforementioned themes in addition to social demographics (such as health, education, and other goods and services).

The majority of the global sustainability-themed and pure-play strategies that we have reviewed currently fit more closely into the broad market or small cap categories within our portfolio construction framework. The following schematic depicts Mercer's view on the role of thematic managers in portfolio construction.

Figure 27: The role of sustainability in equity 2.0



Potential diversification benefits from investing in sustainability themes can include the following, although not all "sustainability-oriented" strategies will necessarily reflect each of these themes:

- Long-term investment horizon — managers highlight that the risk/return trade-off for sustainability themes can be more compelling with a longer time horizon as the macro drivers take effect.
- Exposure to stocks with low coverage — many of the niche and broad sustainability-themed strategies tend to have low overlap with broad benchmarks, such as the MSCI World Index, ranging from 10%–30%.

- Emerging technologies — small cap stocks can offer exposure to emerging technologies as many companies tend to be new and pure play.
- Exposure to stocks with revenue opportunities identified as those typically under-appreciated or under-recognized by the market — for example, the impact of stranded carbon assets, the impact of “fat taxes” on the food and drink industry, and opportunities in healthy foods and healthy lifestyles.

We would be pleased to discuss the merits of including one or more sustainability-themed managers in CalSTRS’ Global Equity portfolio.

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