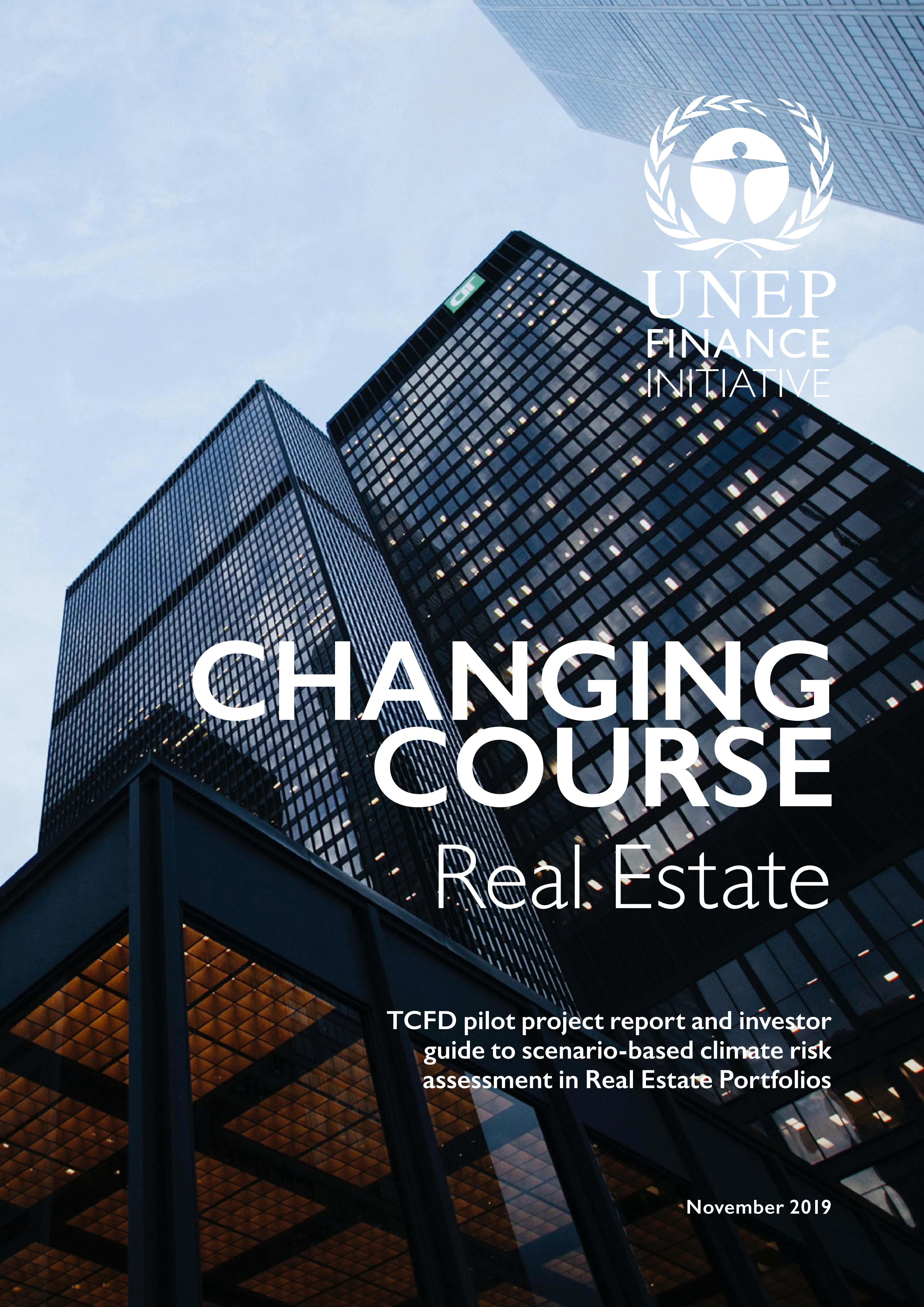

UNEP FINANCE INITIATIVE

# CHANGING COURSE

## Real Estate

**TCFD pilot project report and investor guide to scenario-based climate risk assessment in Real Estate Portfolios**

**November 2019**

Twelve institutional investors from eight countries, convened by UNEP FI and supported by Carbon Delta, have worked throughout 2018–2019 to analyse, evaluate, and test, state-of-the-art methodologies to enable 1.5°C, 2°C, and 3°C scenario-based analysis of their direct property investment portfolios in line with the recommendations of the FSB's Task Force on Climate-related Financial Disclosures (TCFD). The outputs and conclusions of this Pilot are captured in the following report and aim to enhance the understanding and ease adoption of the TCFD recommendations by real estate investors across the wider investment industry.

UN Environment Programme – Finance Initiative is a partnership between UN Environment Programme and the global financial sector created in the wake of the 1992 Earth Summit with a mission to promote sustainable finance. More than 200 financial institutions, including banks, insurers, and investors, work with UN Environment Programme to understand today's environmental, social and governance challenges, why they matter to finance, and how to actively participate in addressing them.

www.unepfi.org

Carbon Delta is a climate change data analytics firm that quantifies investment risks for more than 30,000 companies along numerous climate change scenarios. With our Climate Value-at-Risk (CVaR) model we aim to empower financial institutions with the tools necessary to protect assets from the worst effects resulting from climate change and also help identify new, innovative low carbon investment opportunities.

www.carbon-delta.com

This report, specific to real estate investments, is a follow-on to the May 2019 Changing Course, published by UNEP FI and authored by Vivid Economics. That flagship report was the culmination of the Investor Pilot on TCFD Adoption led by UNEP FI and involving 20 institutional investors, a subset of whom are shown in the logos above. The Pilot was designed to explore, enhance and apply a methodology for assessing the impact of physical and transition risks and opportunities on listed equities, corporate debt, and direct real estate portfolios. As a guide for investors, the May 2019 report includes a market scan of the approaches, tools, and providers available to investors today to apply the TCFD recommendations, with principal methodological details from the approach followed by Carbon Delta. However, the main findings excluded modelling and analyses from the investigation into direct real estate investments, now covered through this report

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# PERSPECTIVES FROM THE PILOT MEMBERSHIP

The planet does not have time for excuses. Investors have a central role to play in moving the world to a low carbon future; this collaboration shows how we can all take better decisions, for our customers and for the environment. Aviva will keep calling for proper disclosure from the companies we invest in, while working with regulators and policymakers to make sure capital markets properly take account of these risks. The cost of doing nothing is far greater than any costs incurred by taking action.

**MAURICE TULLOCH**
**CEO |** Aviva plc

With real estate accounting for one-third of all global carbon emissions, the responsibility is ours to walk the talk on sustainability. Climate risk has added another variable that must be assessed in evaluating "value at-risk" as we develop and implement steps to safeguard our clients' investments in real property against the elements. Taking this action toward resiliency now means that the futures of hundreds of communities and hundreds of thousands of tenants who are connected to the buildings we manage will be better served for years to come.

**GARY WHITELAW**
**CEO |** BentallGreenOak

Climate change is posing a significant threat across many sectors and regions, and businesses must play a key role in ensuring transparency around climate-related risks and opportunities. To accelerate our climate action, we have adopted science-based emissions reduction targets validated by Science Based Target initiative (SBTi) and climate change scenario analysis based on the TCFD recommendations. These efforts aim to future-proof our businesses by identifying risks for mitigation and adaptation with a view to delivering lasting value for our business, investors, stakeholders and the environment at large. CDL is pleased to be part of the UNEP FI Pilot and will continue to uphold our long-established sustainability strategy and pursuing best practice around carbon disclosure.

**SHERMAN KWEK**
**CEO |** CDL Group

As governments around the world struggle to do enough to meet stated emission reduction targets and debate rages as to whether even these targets are adequate, we are increasingly aware of our role in avoiding catastrophic scenarios. We will not solve these wicked challenges alone, making peer research collaborations such as this one, critical to limiting climate change to 1.5°C. While there is still much to be done, insightful transparency in financial exposures will certainly influence global investment practices in the years to come.

**JONATHAN CALLAGHAN**
**CEO |** Investa

A quantitative approach is needed to prioritize the development and deployment of effective asset level climate mitigation strategies. Our participation in the UNEP FI TCFD Pilot is a good start in this direction, enhancing our understanding of the potential risk exposures under different climate scenarios, and of the associated financial impact. This information is used to support our strategic decision-making so that Link can continue to own and manage a productive property portfolio. We look forward to being part of the collaborative effort in implementing further long-term climate resilience strategies.

**GEORGE HONGCHOY**
**CEO |** Link Asset Management Limited

All financial institutions need to understand the risks and opportunities that stem from climate change and the resultant transition to a low-carbon economy. Cognisant of the complexity of this challenge, we see great value in collaborating with our peers in the investment community to develop our collective understanding of the investment implications of future climate scenarios. We look forward to building on these initial efforts and will be using the findings as a crucial first step in stress-testing the resilience of our investments against one of society's greatest challenges.

**JOHN FOLEY**
**CEO |** M&G Prudential

We have increasingly addressed the impact of climate change on our real estate portfolio. Our participation in this pilot allows us to collaborate alongside our peers and disseminate the TCFD recommendations for real estate investors across the wider property investment industry. The pilot provides us the tools to enhance climate risk assessment and scenario-based analysis from qualitative, into quantitative data analysis.

**BILL MCPADDEN**
**Global Head of Real Estate |** Manulife Investment Management

The question is no longer why sustainability should be integrated into decision making, but how to further excel it. The UNEP FI TCFD pilot enabled collaboration among peers, highlighting critical questions on how to improve our work. The in-depth discussions within the team have led to a better understanding on what needs to be done to enhance the knowledge on how to integrate climate-related risks and opportunities during decision making.

**JAN ERIK SAUGESTAD**
**CEO |** Storebrand Asset Management

# FOREWORD

Since the Task Force on Climate-Related Financial Disclosures (TCFD) released its final recommendations in mid-2017, more and more financial institutions across the globe are responding to Bank of England Governor Mark Carney's warning to avoid the 'Tragedy of the Horizon' that climate change represents. Increasingly, leading investors see the link between their ability to generate positive returns and capacity to manage the manifold risks presented by climate change. If effective asset allocation and management decision-making relies upon accessible information on risks institutions and their investments are exposed to and foresight on how those risks imperil value but also create opportunity, TCFD provides the framework to assess, measure and disclose information to key stakeholders internally and externally.

The number of financial institutions that have signed on as supporters of TCFD numbers more than 800 with collective assets exceeding US$100 trillion US dollars. Such take-up by the sector demonstrates their critical role in channelling finance to the real economy that accelerates the low-carbon transition that is urgently needed and builds resilience to the inevitable effects from our historical and present carbon emissions. UNEP FI is proud to have facilitated the application of the TCFD recommendations in dozens of leading FIs through pilot projects with groups of banks, investors, and insurers, respectively. This report is the culmination of one such pilot with twenty investors, a sub-set of which are direct equity investors in real estate and seeking knowledge of the financial implications from climate change's physical and transition risks on those assets. It is a companion to the Changing Course report, released in May 2019, which focused predominantly on investor risk in listed equities and corporate debt.

The building and construction sectors are responsible for approximately one-third of global energy consumption, making them prime targets for emissions reductions in line with a below 2 degrees target. And while in-use energy intensity of buildings is falling, this reduction is less than what is needed to offset the rise in global floor area and to bend the sectors' emissions trajectory firmly downwards. Meanwhile, major severe storms in the second half of 2019 in places such as the United States, Caribbean and Japan starkly illustrate the exposure to extreme weather of high-value buildings and the challenges of managing disruption and maintaining asset value. For the real estate sector then, the challenges are clear. Investors that anticipate regulatory or market pressure to reduce emissions, and that have clearer models on their asset's exposure to extreme weather and the capital planning needed to harden those assets, will be better positioned to increase asset value and avoid stranding.

I commend the investors that have gone through this exercise and committed themselves as champions of TCFD and thoughtful stewards of society's capital. Their experience and knowledge willingly disseminated in this report is helping to accelerate the sustainability journey within their institutions and the larger finance sector that, with respect to climate change, is still in its early stages.

**Eric Usher**
Head, UNEP Finance Initiative

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# EXECUTIVE SUMMARY

There is a strong consensus within the scientific community that anthropogenic climate change is a real and severe threat that will adversely affect both natural and economic systems. The frequency and intensity of extreme weather events is increasing due to historical carbon emissions, and the climate is expected to alter considerably between now and the end of the century. Changing weather patterns will bring both chronic (steady long-term) and acute (event-driven) climate effects that will vary depending on the geographic location.

Buildings are likely to suffer significant damage costs from climate change impacts. The Global Commission on Adaptation warns that rising seas and greater storm surges could force hundreds of millions of people in coastal cities from their homes, with a total cost to coastal urban areas of more than US$1 trillion each year by 2050. And as buildings are energy-intensive to build and operate, they are key targets in global efforts to reduce carbon emissions. As two-thirds of the current overall building stock in most countries is expected to be in-situ in 2050, many will need deep and potentially costly retrofits to increase energy efficiency and switch to lower carbon power sources to meet expected legislative requirements as cities and countries target net-zero emissions. Without such upgrades there is a risk that inefficient buildings could become "stranded".

With their relative illiquidity compared to many other asset types, and from their physical permanent locations and long investment cycles, it is essential that real estate owners and managers identify long-term climate change trends and take adequate risk mitigation measures to maintain and enhance value. To support this identification of risk and action needed in investment decision-making, the Task Force on Climate-related Financial Disclosures (TCFD) recommended that organisations commit to disclosing climate-related activities around governance, strategy, risk management, and metrics and targets.

Beginning in 2018, the UN Environment Programme Finance Initiative (UNEP FI) convened a pilot group of 20 institutional investors to apply the TCFD recommendations. The pilot focused on three asset types, including direct real estate investments. A sub-set of 12 institutions with real estate holdings worked collectively with Carbon Delta, a specialist external provider of climate risk data and analytics, on the development of methodologies for forward-looking, scenario-based assessments of the climate-related risks and opportunities. Using the methodology and data of Carbon Delta, the pilot explored, enhanced, and applied the TCFD recommendations through the lens of Carbon Delta's 'Climate Value-at-Risk' (CVaR) and 'Warming Potential' metrics. This report provides an overview of the Carbon Delta methodology, illustrative results from the climate risk analysis, and details the experiences of those investors working with the tools of scenario analysis through a series of case studies. Finally, the report includes a discussion of the benefits of scenario analysis brings to real estate investment decision-making and where it should be developed further.

The methodology was co-developed through iterative consultations between the participating asset owners and investment managers in the pilot and Carbon Delta. It suits both an asset-level and whole-of-portfolio analysis of the CVaR, assessing the impact of climate change-related transition and physical risks on property market value. The Policy Risk (transition risk) model combines a top-down and bottom-up hybrid methodology to assess policy risks from future efforts to address climate change. The Physical Risk model utilises climate hazard data for the given locations of the assets. The graphic below summarises the approach to calculate the CVaR for real estate.

**Regulatory Transition Risks**


**Physical Risks**


Overview of methodological steps in the Regulatory Transition and Physical Risk computations.

The transition risk modelling includes a 3°C Scenario (equivalent to the NDCs of the Paris Agreement), a 2°C scenario, and a 1.5°C Scenario ("CarbonNetZero"). Emissions reductions required from the buildings sector are based on a *fair share principle*, with the reduction for buildings equal to the share of emissions from buildings out of the country's total emissions. Country-level targets in the 2°C scenario are calculated by amplifying the emission reduction targets in the NDC-compliant 3°C scenario using the 2°C-compliant levels in line with the UNEP Gap report. For 1.5°C levels, the annual reduction requirements are driven by the assumption that all buildings are carbon neutral by 2050.

Emissions reductions were calculated against benchmark emission intensities which are country and building-type specific. Asset-level carbon reductions for Scope 1 and 2 emissions rely on reported/actual data and are compared to reduction pathways for the 3°C, 2°C, and 1.5°C compliant scenarios. The greenhouse gas (GHG) reduction requirements are given a cost to the building owner using modelled future carbon prices according to the scenario. Discount factors are utilised to calculate the present value of the cost of the emission reductions. The results are also displayed as the level of anthropogenic warming an owner's investments correspond to – this is the asset or portfolio's *warming potential*.

The physical risk modelling captures two types of physical climate risk: chronic risks, which manifest slowly over time (extreme heat, extreme cold, and severe wind conditions), and acute risks, which are the result of extreme weather events such as tropical cyclones and coastal flooding. The methodology used to assess physical risks for real estate covers the financial impacts due to asset damage by climatic events and trends for commercial and residential buildings. To quantify physical risks and opportunities, Carbon Delta applies a formula used in most hazard models in the insurance industry which can be represented as:

Expected cost = vulnerability * hazard * exposure


Overview of the three main methodological components of the Physical risk model

Impacts are estimated under a BAU scenario, rather than different policy scenarios. More extreme physical risks are covered in an 'aggressive' scenario, which takes the same scenario but applies a 95th percentile damage level.

The CVaR for chronic risks is derived from costs from physical property damage as well as changes in the operational costs to specific buildings. Thresholds for damage occurrences are calculated for each of the chronic risks, and damage functions assigned for conditions that exceed these thresholds. It is calculated from the numbers of days of exceedances per hazard compared to current conditions, with the change of cost ('delta cost') in relation to the base year. This calculation from asset damages and changes in operating needs are then discounted for the present value. The Climate Value-at-Risk is the present value of cost in relation to gross asset value (GAV).

For acute physical risks, value at risk calculations are based on projections of future intensity and frequency derived from selected hazard models. Costs are quantified based on expected damages, calculated as the product of the value of the facility, and the proportion of damage expected. Similar to chronic risks, the difference between future and current costs from the hazard are assessed and then discounted for present value.

To demonstrate the utility of the modelling and the information generated, assets from several individual participating institutions were pooled into a single portfolio. The data was anonymised so that no specific asset information or owner/manager details are disclosed. Nearly 1,000 assets with a total Gross Asset Value of US$78 billion and total floor area of 180 million $ft^2$ were included. The modelling revealed some of the geographical and building-type specific risks of this sample portfolio and illustrate the outputs from the scenario development and modelling exercise.

The analysis of the portfolio reveals an aggregated CVaR of -1.9% of gross asset value, based on the 2°C transition risk scenario and the average outcome of the physical risk scenario. The value at risk significantly sits with the physical risk: -1.57% of the -1.9% total is due to physical rather than transition risk factors. The findings also suggest that the transition CVaR is more sensitive to the scenario utilised than is the case with the physical risk modelling. The transition costs more than double moving from a 2°C to a 1.5°C scenario. Overall, the portfolio shows a weighted warming potential of 3.16°C. Compared to the global Business-as-Usual (BAU) predicted temperature rise of 3.8°C, the portfolio generally performs better in terms of carbon efficiency compared to industry at large benchmarks but still is some distance from what is collectively needed to avert the worst effects of climate change.

| Policy Transition Risk Scenario | 3°C | 2°C | 1.5°C |
|---|---|---|---|
| CVaR | -0.18% | -0.33% | -0.72% |

| Physical Risk Scenario | Average | Aggressive |
|---|---|---|
| CVaR | -1.57% | -2.24% |

| Aggregated CVaR | 2°C & Average |
|---|---|
| CVaR | -1.9% |

Portfolio aggregated CVaR and breakdown in transition and physical risk

Results from the transition analysis were mapped by region and property type against the asset value and the carbon emission reduction requirements. Properties which have high reduction requirements and a low value per $m^2$ may be considered high risk: these properties could face high retrofitting costs that may be difficult to absorb considering the lower property value. The results from the physical risk exposure projected that the largest additional future costs are from coastal flooding and tropical cyclones, and in particular the former. This is the case even though only a small number of assets within this sample portfolio are exposed to coastal flooding. Using assets in Asia as an example, though the number exposed to coastal flooding compared to tropical cyclones is lower, the total potential loss is 70 times higher.

The modelling showed that average climate Value-at-Risk can appear relatively low across portfolios and selectively for individual assets. However, it may be that the model underestimates the risks due to factors relating to the datasets used in the physical risk model (the model uses historical observation to derive trends for the next 15 years whereas long term climate models predict greater impacts over a longer time horizon); missing hazards to which modelling challenges remain (such as fluvial flooding and wildfire); and modelling being limited to direct impacts and excluding indirect ones (e.g., climate change if unaddressed will create an economy-wide drag on growth and GDP which will indirectly affect real estate values). In spite of these limitations, the pilot succeeded as an innovation and learning exercise and has supported real estate investors in financially quantifying the climate risk in their real estate portfolio, often for the first time.

Moving forward, there are several enhancements Carbon Delta intends to make to the model to build upon the current version described in this report. For instance, the time horizon will be extended to 2050 and several additional scenarios will be provided to help with TCFD reporting and other analyses. Physical hazards such as fluvial flooding and wildfires will be introduced and increasing the resolution of the model will be done continuously through migration to the newest and most powerful updates to the underlying climate models. The transition risk side will see additional dimensions such as pass-through costs and tenancy risk added to the core transition model. In addition, an increase in the granularity of the sectoral breakdown will allow for a more realistic building type model, and the introduction of other sustainability and more traditional real estate datasets will further improve the sophistication of the model. Finally, the ability to view the data in a graphical user interface will help the user intuitively assess their climate risks and help communication within organisations.

# I. INTRODUCTION

There is a strong consensus within the scientific community that anthropogenic climate change is a real and severe threat that will adversely affect both natural and economic systems. The latest special report by the Intergovernmental Panel on Climate Change states with a "high confidence" that human activity has caused global temperatures to rise and that it will have a significant impact if left unchecked (IPCC, 2018). Carbon emissions need to be drastically reduced to avoid the expected temperature rise of 3.8°C from pre-industrial levels, based on the current trajectory

The physical impacts of climate change are increasing in severity and frequency. For instance, in 2019 alone Europe suffered its second unseasonably warm summer in a row, with record-breaking heat waves causing temperatures of over 40°C in many countries, including a high of 45.9°C in southern France. Similarly, Pakistan and India experienced highs of 50.8°C in May and June of the same year—the second longest heatwave ever recorded leading to hundreds of fatalities as well as extreme droughts and water shortages. As this report goes into writing (October 2019) wildfire season in California has already recorded 6,000 fires and widespread precautionary power cuts affecting economic activity.

Furthermore, the climate is expected to change considerably between now and the end of the century. Changing weather patterns will bring both chronic (steady long-term) and acute (event-driven) climate effects that will vary depending on the geographic location. Hazards include heat and water stress, extreme precipitation, cyclones/storms, and rising sea levels. The severity and frequency of such events will depend on decarbonisation efforts globally, with earlier and stronger reductions in emissions lowering the resulting overall impact of physical climate risk.

Public policy and private action are aligning with strengthening political commitment as global leaders implement measures to keep temperatures to "well below 2°C"as set out at the UN Climate Summit in Paris in 2015. The second set of nationally determined contributions (NDCs) are due to be re-committed by the parties at UNFCCC COP26 in December 2020 (nearly 90 countries have registered building-sector actions in their current NDCs). In September 2019, 77 countries and more than 100 cities committed to net zero carbon emissions by 2050 at the Climate Action Summit; and 3,000 city-level commitments are registered under the United Nations Framework Convention on Climate Change. Unconventional actors such as states in the US, cities, and universities have stepped up commitments in tandem with a wave of global civil action demanding further and more immediate carbon emission reduction.

## BOX – LATEST SCIENCE

An outtake from the latest IPCC report on The Ocean and Cryosphere in a Changing Climate shows the historical and projected changes (Figure 1) in certain water-based natural systems between 1950 and 2300 for low (RCP2.6) and high (RCP8.5) greenhouse gas (GHG) scenarios (IPCC, 2019). While it only looks at a small selection of the total natural systems, it shows graphically what difference an ambitious GHG reduction policy could make. However, over a 15-year time horizon, the near-term consequences are set regardless of decarbonisation efforts.

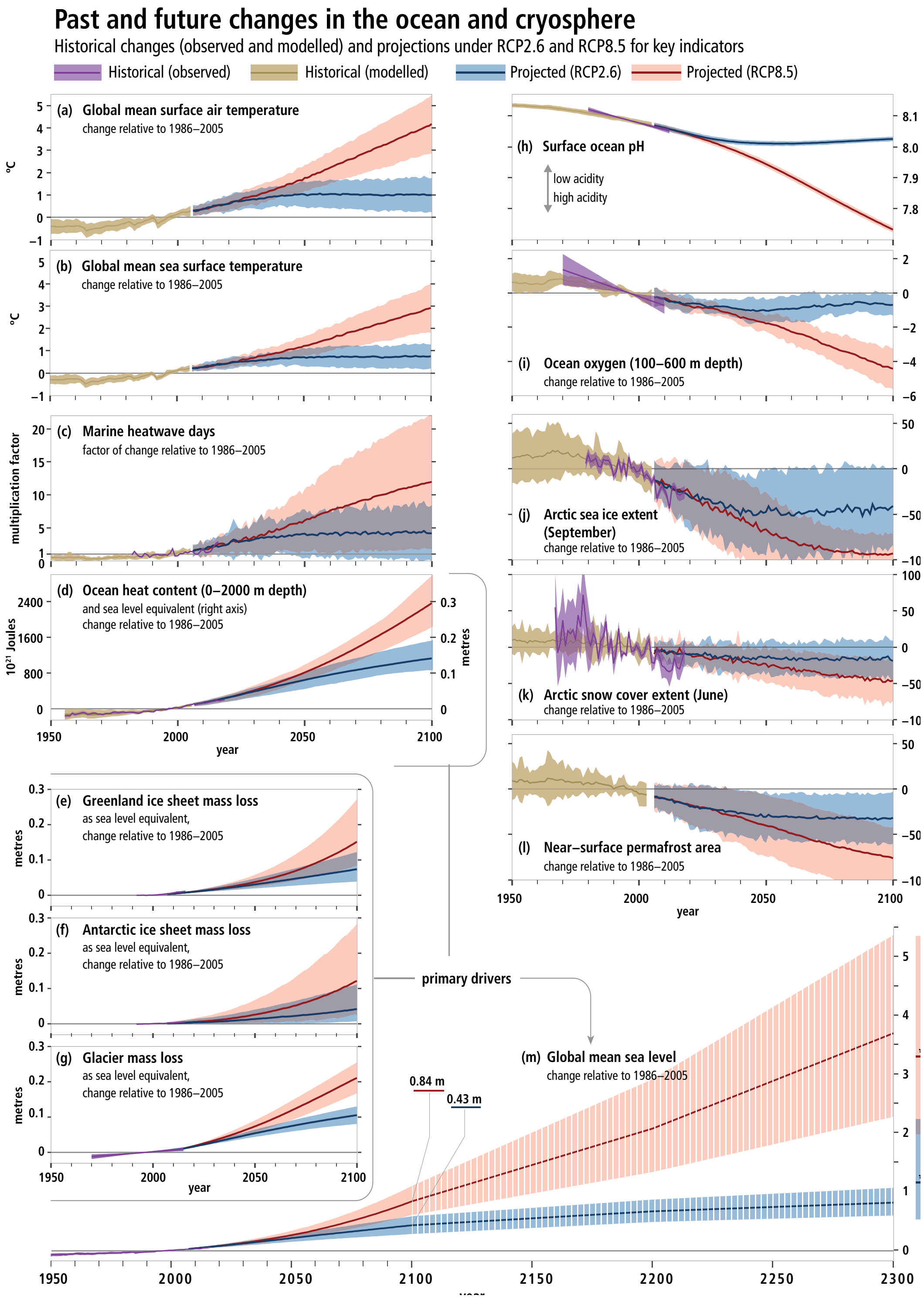



**Figure 1**: Changes to observed and projected key indicators of changes in the ocean and atmosphere for a RCP2.6 ad RCP8.5 scenario (Figure from IPCC, 2019).

Real Estate is a significant asset class, as the size of the professionally managed global real estate investment market is worth US$8.9 trillion[1] (MSCI, 2018). Buildings provide valuable income and capital appreciation possibilities to investors but, as long-life fixed assets, face unique climate change related vulnerabilities to both physical and transition risks.

The physical impacts of climate change on the built environment are becoming more significant and have the potential to be extremely costly. It is estimated that forty per cent of the world's population now lives within 100 kilometers of a coast (United Nations, 2017). The Global Commission on Adaptation warns that rising seas and greater storm surges could force hundreds of millions of people in coastal cities from their homes, with a total cost to coastal urban areas of more than US$1 trillion each year by 2050. With their locations fixed, buildings themselves are likely to suffer significant damage costs from climate change impacts.

More so, buildings are energy-intensive to build and operate. They are responsible for 36% of global final energy consumption and almost 40% of total direct and indirect $CO_2$ emissions, with operational emissions mostly through space heating and cooling, and water heating (IEA, 2019). Despite floor space that is expected to grow globally by 3% per year (predominantly in India and China), the current building stock will still represent over 2/3 of the overall building stock in most countries in 2050 (GABC, 2016). Such stock will likely need deep and potentially costly retrofits to increase energy efficiency and for power-source changes required to meet expected legislative requirements as cities and countries target net-zero emissions. Without these upgrades there is a risk that inefficient buildings could become "stranded"[2]. Indeed, the International Energy Agency (IEA) rates the progress of Buildings as "Not on Track" towards a sustainable energy transition and that "assertive action is needed" to prevent the lock-in of long lived, inefficient building investments (IEA, 2017).

### BOX – TRANSITION FOCUS: NEW YORK CITY'S "CLIMATE MOBILISATION ACT"

In NYC, buildings contribute 67% of the city's greenhouse gas emissions through lighting, heating and other operations (Majersik, C., 2019). As the US federal government has limited its support for climate change initiatives, many US cities and states have filled the leadership void with their own actions. New York City is one such leader, having passed a set of bills in mid-2019 aiming to align the city with the Paris Agreement.

It consists of eight bills with the flagship initiative relating to the carbon emissions of buildings, with the effect to reduce emissions levels in line with the Paris Agreement (i.e., emission reductions of 80% by 2050). It focuses on large buildings (>2,300m³) and comes into effect in 2024, with a substantial tightening of emission caps in 2029.[3]

The bill stipulates that each building is allocated a carbon allowance that gets stricter over time, based on building type and square footage. The owner can lower its emissions by retrofitting with energy efficiency measures and installing renewable energy. If its actual emissions are higher than the building's budget, it is fined US$268/ton $CO_2$e, leading to potential fines exceeding US$1m if buildings fail to cut their emissions. Note that 10% of the emissions can be offset, e.g. by purchasing renewable energy credits.

Other bills instruct that all new construction and retrofits will be required to have either solar panels or a green roof (or both); and create a provision for Green Labelling which redefines the energy efficiency grades of buildings (ratings from A-E). which must be published and displayed

The Act is estimated to cumulatively cost building owners US$4bn, though this does not account for lower operational costs (Spivack, C., 2019). A further bill within the Act relates to the finance of such initiatives and to help building owners pay for the initiative in a way that allows upgrades to be cash-flow neutral, encouraging retrofits.

**"This package of bills will be the single largest carbon reduction effort in any city, anywhere [...] that has been put forward"**

Committee for Environmental Protection Chair, Costa Constantinides

1. For context, the size of the global equity and bond markets have been estimated at around US$75 trillion (Baccardax, M., 2017).
2. Stranded assets are properties that will be increasingly exposed to the risk of early economic obsolescence due to climate change because they will not meet future regulatory efficiency standards or market expectations. These buildings will become less marketable and may require costly refurbishment measures. (CREEM, 2019)
3. It is estimated that between 75–80% of buildings are already compliant to at least 2029 standards.

The illiquidity of physical and permanently located buildings, and long investment cycles in real estate also mean it is essential to identify long-term climate change trends and take adequate risk mitigation measures. Some insurers are already signaling that climate change may make buildings uninsurable in the future. Insured losses in 2017 in the US were the highest on record and 2018 the fourth costliest, due to major hurricanes and other weather events that can be linked to climate change and were described as a ”sign of things to come“ (Munich RE, 2018). Indeed, leading insurers such as AXA SA are signaling that in a 3°C or 4°C scenario, some buildings from New York to Mumbai will no longer be insurable (Hirtenstein, A., 2018).

To combat the systemic risk of climate change, Mark Carney, Governor of the Bank of England and—at the time—Chair of the G20's Financial Stability Board, asked then-UN special envoy on climate change, Michael Bloomberg, to chair the Task Force on Climate-related Financial Disclosures (TCFD). The TCFD recommended that organisations commit to disclosing climate-related activities around governance, strategy, risk management, and metrics and targets. Support for the recommendations has steadily grown; by September 2019 867 public-and private-sector organisations had announced their support for the TCFD and its work, including global financial firms responsible for assets over US$118 trillion (TCDF, 2019).

A UNEP FI Investor Pilot on TCFD Adoption, a collaborative effort of 20 institutional investors to develop methodologies for forward-looking, scenario-based assessments of the climate-related risks and opportunities faced by their portfolios, was conducted throughout 2018 and 2019. Using the methodology and data of Carbon Delta, the pilot explored, enhanced, and applied the TCFD recommendations through the lens of Carbon Delta's Climate Value at Risk' (CVaR) and 'Warming Potential' metrics. The results can be seen in the "TCFD Changing Course" report, published in May 2019. It found that investors face as much as 13.16% of risk from the required transition to a low-carbon economy (using a 'market portfolio' benchmark of 30,000 equally weighted companies). Considering that total assets under management (AUM) for the largest 500 investment managers in the world total US$81.2 trillion, this would represent a value loss of US$10.7 trillion. Companies face increased cost, and investors increased risk, if governments act late. If governments delay action to enact climate policies that reduce greenhouse gas (GHG) emissions, the 30,000 companies in the universe face a further cost of US$1.2 trillion as compared to a scenario where climate policy is enacted smoothly and steadily with immediate effect.

This report details the results from this UNEP FI Investor Pilot for the investigation into Real Estate as an asset class. Through working with a sub-group of 12 investors within the total group of 20, this report details the experiences of those investors working with the tools of scenario analysis through a series of case studies. Also included is an aggregated analysis of those investor's portfolios from a transition and physical risk perspective. Finally, the report includes a discussion of the benefits of scenario analysis brings to real estate investment decision making and where it should be developed further.

# 2. METHODOLOGY

This section provides a description of the Carbon Delta methodology co-developed in the UNEP FI Investor Pilot through iterative consultations between the Investor Pilot Group and Carbon Delta. It lays out a framework to calculate the Climate Value at Risk® (CVaR) metric for real estate assets and portfolios. The CVaR metric assesses the impact of climate change-related risks and opportunities on an asset's market value over a 15-year time horizon. The risk at the portfolio level is determined through upwards aggregation, taking into account real estate assets and their location. This section describes the process by which climate change risks and opportunities are identified, modelled, and quantified into costs and revenues. It also details the methodology by which these costs are aggregated to a CVaR for real estate assets.

The Policy Risk model combines a top-down and bottom-up hybrid methodology to assess policy risks from future efforts to address climate change. Carbon Delta's model currently analyses three regulatory transition scenarios: 3°C, 2°C and 1.5°C-scenarios. The 3°C and 2°C scenario are based on NDCs as generated through the Paris Agreement. The 1.5°C-scenario defines an even more ambitious target, where carbon neutrality is reached in 2050. Asset specific emission data is combined with sectoral reduction trajectories for each scenario. This allows to compute reduction requirements and associated costs for each scenario.

The Physical Risk model utilises climate hazard data for the given locations of the assets. It uses a similar approach as the equity and fixed-income methodologies utilised in the UNEP FI Investor Pilot, however with a few exceptions. Physical Risk in the Real Estate Model considers the events of Extreme Heat, Extreme Cold, Coastal Flooding, Tropical Cyclones and Extreme Wind. For the Extreme Heat and Cold, additional cost of heating and cooling is determined by defining a cost of exceeding a specific temperature threshold. For the Coastal Flooding, Tropical Cyclones and Extreme Wind, vulnerability functions are used to calculate the loss due to damage of buildings.

Figure 2 shows the basic data flow and methodological steps in the Physical and Regulations Risk computations respectively.


**Figure 2:** Overview of methodological steps in the Physical and Policy Risk computations.

## 2.1. REGULATORY TRANSITION SCENARIO ANALYSIS FOR REAL ESTATE

Using a top-down and bottom-up hybrid methodology, regulatory risks from future efforts to address climate change are calculated, based on the policies embedded in the NDCs. Carbon Delta's model currently analyses three regulatory transition scenarios, a 3°C Scenario (equivalent to the NDCs of the Paris Agreement), a 2°C scenario and a 1.5°C Scenario ("CarbonNetZero"), each integrating emission reduction prices from integrated assessment models (IAMs)[4]. It should be noted that, unlike the corporate equity and debt models, technology risk is not included.

The Carbon Delta methodology for assessing transition policy risk begins with the quantification of country-level GHG reduction targets defined by the NDCs and aligned with PIK's REMIND model. This would lead to approximately 3°C of warming above pre-industrial levels. Following the fair share principle, it is assumed that the reduction for buildings equal the share of emissions from buildings out of the country's total emissions. Country-level targets in the 2°C scenario are calculated by amplifying the emission reduction targets in the NDC-compliant 3°C scenario using the 2°C-compliant levels in line with the UNEP Gap report. For 1.5°C levels, the annual reduction requirements is driven by the assumption that all buildings are carbon neutral by 2050.

Benchmark for assets are estimated by adopting average emission intensities, which are country and building-type specific. Reduction pathways per floor area for both residential and commercial buildings are then computed using the benchmarks as starting points. It is additionally assumed that floor area will increase in the future, and thus affect the total reduction requirements. Therefore, floor area growth estimates from the Global Energy Assessment (GEA, 2012) are added to the reduction requirements.

A key element of the model is that actual (rather than estimated) scope 1 and 2 emissions are used for each asset for comparison to the benchmark pathways. This data is provided by the asset owner. Should the information not be available, scope 1 and 2 emissions are estimated using the country and building-type specific benchmarks.

The reduction requirements for the asset is the difference between emission level and the benchmark pathway to reach the specific scenario target (3°C, 2°C and 1.5°C). This is used to track the delta between current emissions and the projected pathways over the next 15 years and is measured in $CO_2e$.

These GHG reduction requirements are given a cost to the building owner using modelled future carbon prices according to the scenario. The GHG price for 3°C scenario is calculated via the "INDC-extended" scenario of the PIK REMIND model. These forecasted emission reduction prices, corresponding to the NDC goals, are a good estimation of the cost associated with reaching the NDC targets in countries and regions. The 2°C and 1.5°C GHG price is calculated by the "2°C-Immediate" and 1.5°C scenario of PIK's REMIND model and are an equivalently good estimation of the cost associated with reaching the 2°C and 1.5°C targets in those countries and regions. The yearly cost to the building is calculated as the product of emission reduction requirement for that asset and the modelled carbon price for that geographical location and year.

4. IAMs aim to generate useful information for policy making, by analysing various scenarios for future pathways. They integrate knowledge from two or more domains into a single framework, for example coupling representations of the economic, energy and climate systems. Carbon Delta uses Regional Model of Investments and Development (REMIND) model from the Potsdam Institute for Climate Research (PIK), and also models from the World Resources Institute (WRI) as well as the United Nations Environment Programme (UNEP).

Classical financial modelling is used to translate future costs to the present, and the 1.5°C, 2°C and 3°C Policy Value-at-Risk is the present value of cost in relation to gross asset value of the property. Costs are extrapolated until the end of life of the building. This end of life can be provided by the user or assumed as default of 40 years for commercial or 60 for residential from last retrofit. However, a minimum of 10 years is set. The total present value of future costs is discounted using a default discount factor of 8%, but that can be specified for each asset by the user. For the 1.5°C scenario, costs are assumed zero after 2050, in accordance to the NetZero Building target.

## 2.2. WARMING POTENTIAL

Investors and other stakeholders increasingly want to know whether their asset or portfolio is aligned with global targets, such as a 2°C or 1.5°C world. Using a carbon emissions intensity on its own can assist, but there are two drawbacks to this approach. Firstly, one has to have an extremely advanced level of climate literacy to understand what carbon values mean and where they sit in the context of global decarbonisation needs. Secondly, each country has different reduction requirements depending on its regional climate and the host country's distribution of reduction efforts. Carbon Delta has therefore developed a more intuitive approach to help investors understand what level of anthropogenic warming its investments correspond to.

The warming potential for a real estate property is computed by assessing the property's carbon intensity against a warming curve valid for the property type and country in which the property is located it. Figure 3 illustrates how the warming potential is calculated for a hypothetical property, *X*, of a specific property type in country *Y*.

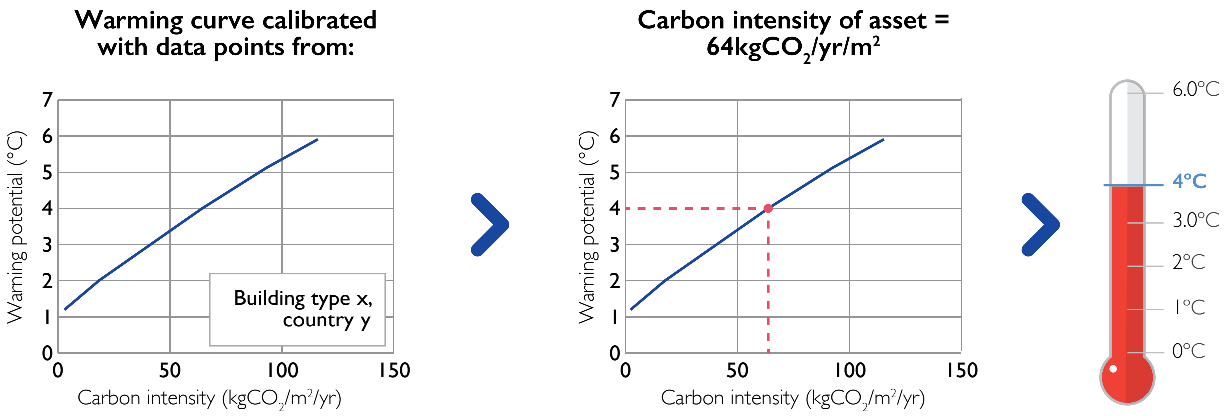



**Figure 3:** Overview of steps to compute the warming potential for real estate property.

Warming functions are defined by the relationship between the carbon intensity (I) and the temperature (t). A logarithmic t/I relation is assumed, which is calibrated with country and building-type specific temperature-carbon intensity pairs (see Table 1). The curve has a floor and ceiling of 1.3°C and 6°C, aligned to the best- and worst-case global scenarios cited by the IPCC. Finally, a building's specific carbon intensity is inputted into the t/I function, and the corresponding temperature can then be computed.

| | Temperature | Source/intensity |
|---|---|---|
| **Business-as-usual** | **3.8°C** | The carbon intensity is derived from the current average energy intensity and fuel mis for the building type in the country |
| **NDC/3C** | **3°C** | The temperature - carbon intensity pair corresponds to the NDCs. The reduction requirements defined in the NDC are combined with estimates of floor area growth and the target carbon intensity is then derived by combining the reduction requirements with the average carbon intensity for the property type. |
| **2C** | **2°C** | The temperature - carbon intensity pair corresponds to the reduction requirements defined in the UNEP Gap report to limit global warming to 2°C |
| **CarbonNetZero until 2050 (1.5°C)** | **1.5°C** | The temperature - carbon intensity pair corresponds to the net zero carbon target. Carbon neutrality in the building sector is assumed by 2050. The 2050 target in interpolated to derive the target intensity in 15 years. |

**Table 1:** Temperature and Carbon intensities used to calibrate the t/I relation in the Warming Potential computations.

## 2.3. PHYSICAL RISK ANALYSIS FOR REAL ESTATE

The Carbon Delta methodology models two types of physical climate risk: chronic risks, which manifest slowly over time, and acute risks, which are the result of extreme weather events such as tropical cyclones. The methodology used to assess physical risks for real estate covers the financial impacts due to asset damage by climatic events and trends such as extreme heat, extreme cold, coastal flooding, tropical cyclones, and extreme wind for commercial and residential buildings. Impacts are estimated under a BAU scenario, rather than different policy scenarios. The rationale for this is that the analytical time horizon for the pilot is for 15 years, and the world is expected to warm at a similar rate in that period regardless of mitigation efforts between now and 2030. More extreme physical risks are covered in an 'aggressive' scenario, which takes the same scenario but applies a 95$^{th}$ percentile damage level. Assessment methodologies for chronic and acute risks are discussed in turn below.


**Figure 4:** Physical risk hazards covered in the physical risk analysis.

The physical risk analysis focuses on building damages caused by extreme weather events and additional costs related to temperature changes (e.g. additional cooling costs). To quantify physical risks and opportunities, Carbon Delta applies a formula used in most hazard models in the insurance industry (see Figure 5), which can be represented as follows:

Expected cost = vulnerability * hazard * exposure


**Figure 5:** Overview of the three main methodological components of the Physical risk model.

## 2.3.1. Chronic risks

Impacts from chronic risks manifest primarily through physical damage or changes in the operational costs to specific buildings. The Carbon Delta methodology considers the effects of three climate hazards: extreme heat, extreme cold, and severe wind conditions[5]. Carbon Delta uses a global historical dataset covering the last 39 years from the European Centre for Medium-range Weather Forecast's ERA Interim Reanalysis project to assess the impact of these hazards. Historical data is used to project an annual distribution of the relevant climate variables under a BAU scenario for the coming 15-year period.

Thresholds for damage occurrences are calculated for each of the chronic risks, and damage functions assigned for conditions that exceed these thresholds. The thresholds are > 30°C and >35°C for extreme heat and <0°C and <-10°C for extreme cold temperatures, and gusts of 24 m/s and 28 m/s for severe wind. The Hazard (sometimes called Risk or Impact) is the risk that for any given location, conditions exceed the damage thresholds.

Figure 6 illustrates how climate scenarios project exposure to Extreme Heat. The current frequency of extreme heat events is shown in the upper map, whereas the lower shows the expected change of extreme heat events. In geographies such as Brazil and Central Africa, which already face exposure to frequent extreme heat events (upper map), are expected to be even hotter. Regions such as the USA and Central Europe are likely to face significantly more frequent heat extremes (lower map).

5. Note that, unlike the corporate equity and bond models developed through the UNEP FI TCFD Investors Pilot, extreme rainfall and snowfall are not included in the real estate model.

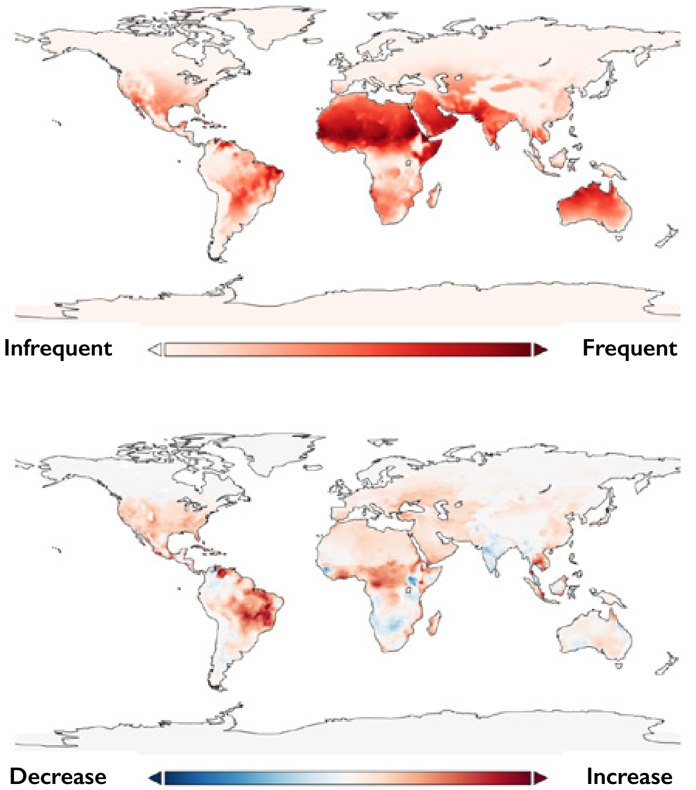



**Figure 6:** Current distribution of extreme heats (upper map) and the predicted change of extreme heat (lower map) across the globe.

For each hazard, a damage function has been developed to ascertain the likelihood of damage for each unit of weather greater than the threshold. This is done for commercial and residential property types and is referred to as the Vulnerability (sometimes called Sensitivity or Susceptibility). It is calculated as numbers of days of exceedances per hazard, compared to current conditions. For severe wind this is expressed as a percent of damage to the building (in terms of gross asset value). For heat and cold, the change in heating and cooling costs are calculated. These are then mapped geographically and overlaid with an asset's location to understand the potential Exposure of a particular building. This Exposure (sometimes called Assets or Inventory) is the presence of a building in an area that could be adversely affected, and in the model, the geographical location, size, type and value of the asset is captured.

The impact of climate change on (chronic) physical risks is determined by the change of cost ('delta cost') in relation to a base year. It is important to note that today's climate has already undergone significant changes due to anthropogenic GHG emissions. Looking forward, it is crucial to determine only the projected difference between today's climate and the future climate. The Carbon Delta methodology assumes that today's climate with its current profile of physical hazards and exposures is already priced into assets. Accordingly, the delta of the costs in any given year is calculated as:

Delta cost = cost future year − cost base year

Since both the current (base year) and the future cost (future year) are modelled, a cost reduction over time will manifest as a net gain. An example of this is the relationship between extreme cold and building costs. As large areas of the northern hemisphere are projected to experience a significant temperature increase, cold extremes become less frequent and the corresponding costs are reduced.

The costs for assets due to damages and changes in operating needs are calculated and total present value of future costs are discounted using Dividend Discount Model. The Climate Value-at-Risk is the present value of cost in relation to gross asset value (GAV).

## 2.3.2. Acute risks

### Tropical Cyclones

Projections of the future frequency and intensity of tropical cyclones are obtained from the open source natural catastrophe model CLIMADA. The model is based on a similar insurance model and is currently maintained by ETH Zurich. CLIMADA uses a stochastic tropical cyclone generator based on an extensive dataset of historical storms. For each property location the distribution of wind speeds is evaluated and combined with regionally calibrated damage functions to obtain a distribution of asset damage costs.

The financial impact of tropical cyclones is quantified as the amount of damage done to fixed assets. The damage expected annually for each property is calculated as the product of the value of the facility, and the proportion of damage expected. The cost delta is again estimated as the difference between future and current costs and discounted to obtain CVaR figures.

### Coastal Flooding

The Carbon Delta methodology models the asset damage due to the impact of coastal flooding. In order to determine flood damages, the inundation of an asset at a given site is modelled depending on the local topography and the statistical distribution of extreme sea levels at the coast. The Carbon Delta methodology employs a bias-corrected version of the global digital elevation model SRTM to determine if an asset will be reached and subsequently inundated by a flood event. It then combines the height of the inundation at the asset site with depth damage functions to determine the fractions of asset damage.

The occurrence and intensity of flood events is modelled via a Poisson process[6] and extreme value statistics, respectively. Local flood protection levels are incorporated into the model via the related return period of the design flood height. As a default, we assume a minimum local protection height at the level of the 100-year flood event. The local protection height is increased beyond the 100-year level, where local information on higher protection levels is available. Protection levels are kept constant over time.

For future years, the local distributions of extreme sea levels are shifted according to the expected regional sea-level rise. The shift typically translates into more frequent and intense flood events. The methodology makes use of a large ensemble of sea-level rise scenarios given in the IPCC's 5th Assessment Report.

The cost delta is again estimated as the difference between future and current costs.

6. In a Poisson (counting) process the number of points (or events) in a given time interval follows a Poisson distribution. The Poisson distribution is defined by the expected number of events and determines the probability of observing different counts of events during the time interval. The intensity of each extreme event is modelled as a Generalized Pareto Distribution, which describes the extreme value statistics of single flood events.

# 3. AGGREGATED DATA ANALYSIS

This chapter presents an analysis performed on a portfolio consisting of the aggregated assets from several of the participating institutions in the pilot. The analysis is anonymous, and no asset information is disclosed. The aim is to analyse the climate resilience of the anonymised aggregated portfolio and understand some of the geographical and building-type specific risks that emerge to illustrate the outputs from the scenario development and modelling exercise.

## 3.1. AGGREGATED PORTFOLIO

The aggregated portfolio used for the analysis contains 959 assets, with a total Gross Asset Value (GAV) of US$78 billion and total floor area of 180 million ft2. Asset allocation based on GVA is predominantly Retail (50%) and Office (32%). The remaining assets are divided between Industrial, Residential and Others (such as medical centers). Allocation per number of assets is led by Retail at 40%, followed by Office and Industrial (23% both). The allocation of Gross Asset Value by building type and as well as country is shown in Figure 7.

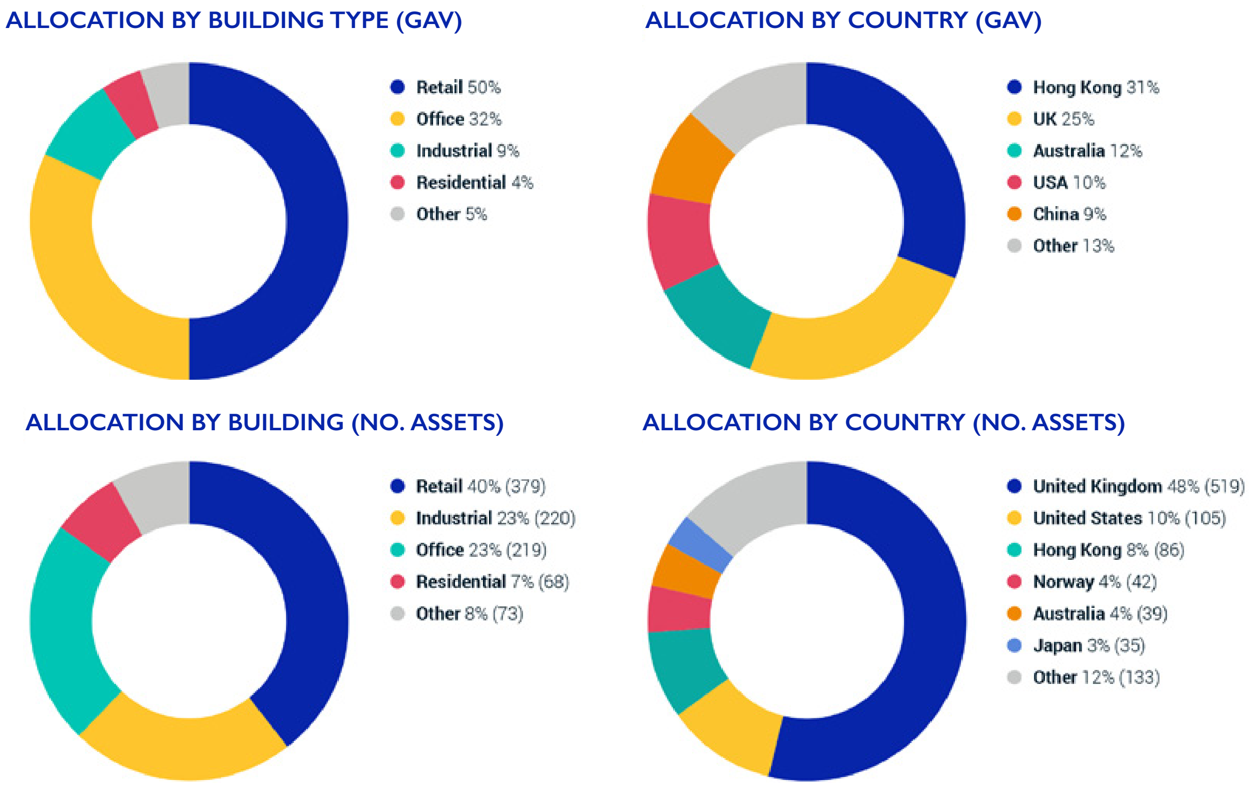



**Figure 7:** Allocation by building type and country for the aggregated portfolio. The upper charts show the allocation by gross asset value, the lower graphs by number of assets.

## 3.2. CLIMATE VALUE-AT-RISK

The CVaR of the portfolio is presented in Table 2. It shows increasing transition risk with more stringent policy requirements, with over four times the Value-at-Risk for a 1.5°C target compared to a 3°C target. Likewise, a more aggressive risk outcome of the physical risk scenario ($95^{th}$ percentile of the distribution) poses a larger threat compared to the average outcome, with almost an almost 50% increase in the risk. The aggregated CVaR shown in Table 2 is the sum of the 2°C transition risk scenario and the average outcome of the physical risk scenario. The overall value at risk is skewed significantly toward the physical risk: -1.57% of the -1.9% total is due to physical rather than transition risk factors. The findings also suggest that the transition CVaR is more sensitive to the scenario utilised than is the case with the physical risk modelling.

| Policy Transition Risk Scenario | 3°C | 2°C | 1.5°C |
|---|---|---|---|
| CVaR | -0.18% | -0.33% | -0.72% |

| Physical Risk Scenario | Average | Aggressive |
|---|---|---|
| CVaR | -1.57% | -2.24% |

| Aggregated CVaR | 2°C & Average |
|---|---|
| CVaR | -1.9% |

**Table 2:** Portfolio aggregated CVaR and breakdown in transition and physical risk.

The aggregated CVaR can be read as a low figure and might not be of great concern for investors. However, this view ignores both the significant difference between the average and aggressive physical risk scenario as well as the sensitivity of the transition risk scenarios when moving from 1.5°C to 3°C. Further, the variances between portfolio average and individual asset risk (shown in Figure 8 further below) indicate a wide risk spread within the portfolio and that individual assets can be at high risk even if the portfolio CVaR is comparably low.

Note that the physical risk model currently only captures the forthcoming 15 years in detail and uses these 15 years to extrapolate further into the future. The projected value impacts are already 'locked-in' due to historical carbon emissions which are affecting present and near future climatic conditions. These costs are largely independent of any carbon emission reductions (even aggressive reductions) that may eventuate during the 15-year modelling period. Long term climate models predict greater impacts over a longer time horizon.

**BOX – CARBON DELTA'S CLIMATE VALUE-AT-RISK FOR REAL ESTATE**

The Climate Value-at-Risk (CVaR) represents a portfolio's or an asset's risk exposure to climate change. Carbon Delta models the policy transition risk and physical risk in this context. The CVaR represents the combined discounted transition policy risk costs and the extreme weather event costs expressed as a percentage of the portfolio's value or an asset's gross asset value.

The forward-looking metric allows investors to understand climate change risk in their portfolio, identify risks today, and implement adaptation and mitigation measures helping asset owners manage limited resources and maximise impact.

In addition to the portfolio aggregated CVaR presented in Table 2, it is also useful to look at the spread among the different assets. Figure 8 shows both the weighted average of the portfolio, as well as the minimum, maximum, and arithmetic average value for the aggregated CVaR. Noteworthy from the graph is that despite the low aggregated CVaR, the portfolio contains outliers facing a risk of a CVaR amounting to -100%. Breaking down the CVaR on asset level hence allows for a better risk representation showing those assets which are at very high risk.

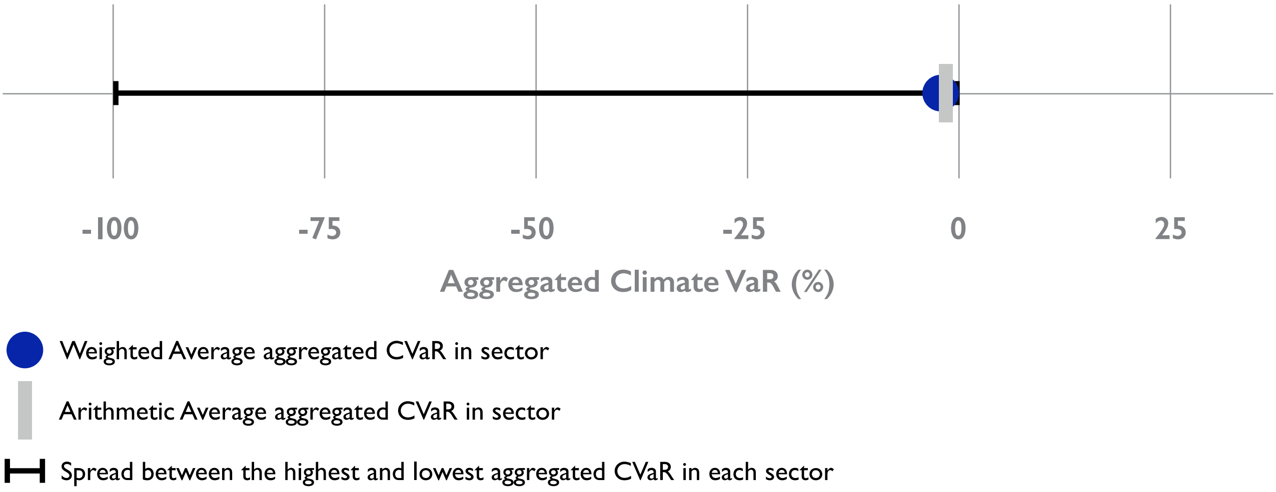



**Figure 8:** Spread of aggregated CVaR showing the riskiest and least risky asset within the portfolio

## 3.3. WARMING POTENTIAL AND POLICY RISKS

The Warming Potential allows investors to understand the alignment of the portfolio to the global 2°C target. The aggregated portfolio has a warming potential of 3.16°C (Figure 9), which means that the portfolio is currently in breach of a global 2°C target. The global Business-as-Usual (BAU) predicted temperature rise is currently 3.8°C. This indicates that the properties in the portfolio are generally performing better in terms of carbon efficiency compared to industry at large benchmarks, but still at some distance from what is collectively needed to avert the worst effects of climate change.

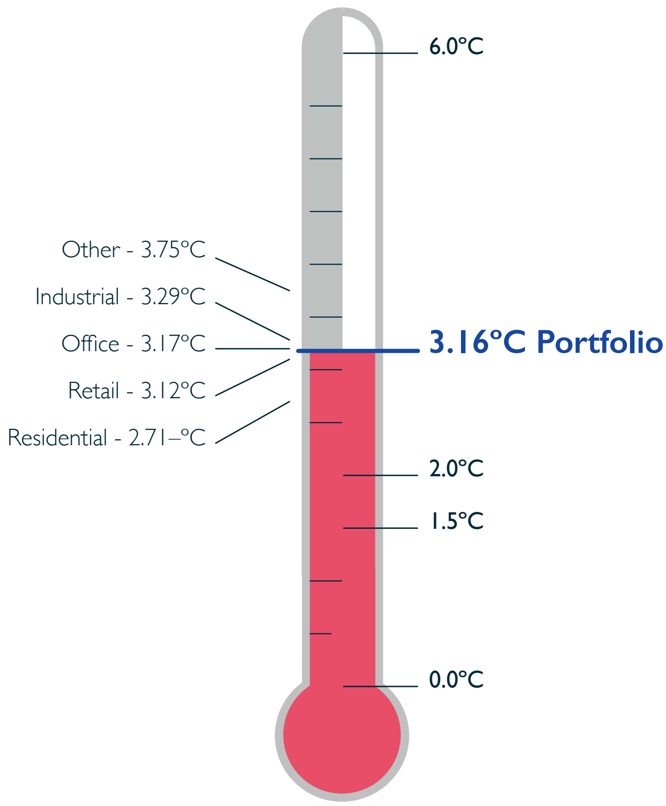



**Figure 9:** Warming potential of the portfolio along with the breakdown per each building type.

The warming potential for each different property type is summarised below.

- Residential properties (4% of gross asset value) are the most aligned to a 2°C world, with a warming potential of 2.71°C. This alignment is mainly driven by the high number of assets which are already outperforming sectoral benchmarks in terms of carbon intensity: about 80% of the residential properties have a lower carbon intensity than the benchmark. This is compared to the overall portfolio where only 50% of the assets (by number of assets) have a lower carbon intensity as compared to the benchmarks.
- The average warming potential of the retail (3.12°C) and office (3.17°C) properties are both closely aligned to the aggregated portfolio warming potential of 3.16°C. Both building types together account for over 80% of the portfolio and are therefore the main drivers of the total aggregated portfolio warming potential. In both retail and office, the temperatures span a wide range—from a 1.3°C floor to a 6°C ceiling which are the lower and upper figures set in the model to account for best- and worst-case global climate scenarios.
- Industrial properties (9% of portfolio gross asset value) are less aligned to the global 2°C target compared to the key property type allocations. Within the sub-group one can again find assets which span the full range of warming potential (1.3°C-6°C). For 59% of the industrial assets, no emission data was available, and the warming potential calculations had to be performed with emission estimates. As the emission estimates are based on average energy intensities per country, these properties have the business-as-usual warming potential of 3.8°C assigned. A similar story is seen for the properties classified as Other (5% of gross asset value). For those building types, the share of estimated emissions is even higher at 70% (i.e., only 30% of assets have reported data).

For the weighted warming potential analysis, the aggregated portfolio was further grouped into five geographic regions[7]. Figure 10 shows the warming potential per region.

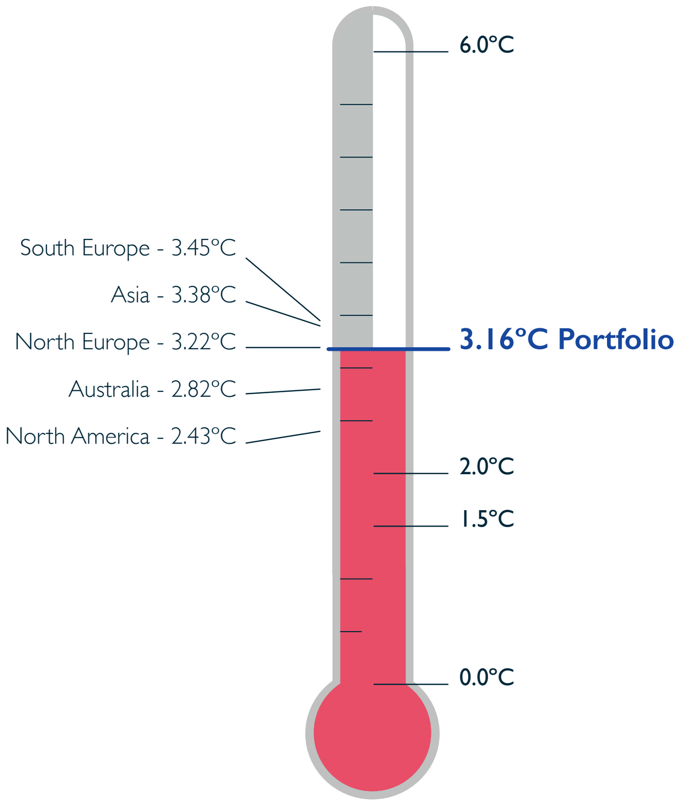



**Figure 10:** Warming potential of the portfolio along with the breakdown per each geographic region

7. The five regions are Australia, Asia (Hong Kong, China, Japan, Singapore, South Korea), North America (Canada, United States of America), North Europe (Belgium, Denmark, Finland, France, Germany, Ireland, Luxembourg, Netherlands, Norway, Poland, Sweden, United Kingdom), South Europe (Italy, Portugal, Spain).

South Europe, at 3.45°C, has the highest warming potential, closely followed by Asia and North Europe. As described in Section 2 - Methodology, a country's NDCs are considered when modelling the warming potential. This means that properties in countries with an ambitious NDC need to achieve higher reduction in order to achieve a good temperature alignment. Italy, Spain and Portugal (South Europe) are all committed to ambitious reductions under the Paris Agreement, which would be a partial driver in the higher warming potential seen in this analysis.

The North American properties are the most aligned group, with a warming potential of 2.42°C. This is mainly driven by the high number of properties with low carbon intensity compared to benchmarks in North America: 75% of the assets are already outperforming the benchmarks. On the other hand, having one nationwide benchmark may cause discrepancy. For instance, in a country like the US with its climatic diversity, it may be difficult to set a benchmark that is representative for the entire country and applicable to building's energy consumption.

In Figure 11 the assets are grouped by geographic region and property type. The graph shows the average value of property per m², and the average reduction requirements per m² for each building type group. The size of the bubble corresponds to the market size the asset grouping represents in the aggregated portfolio.

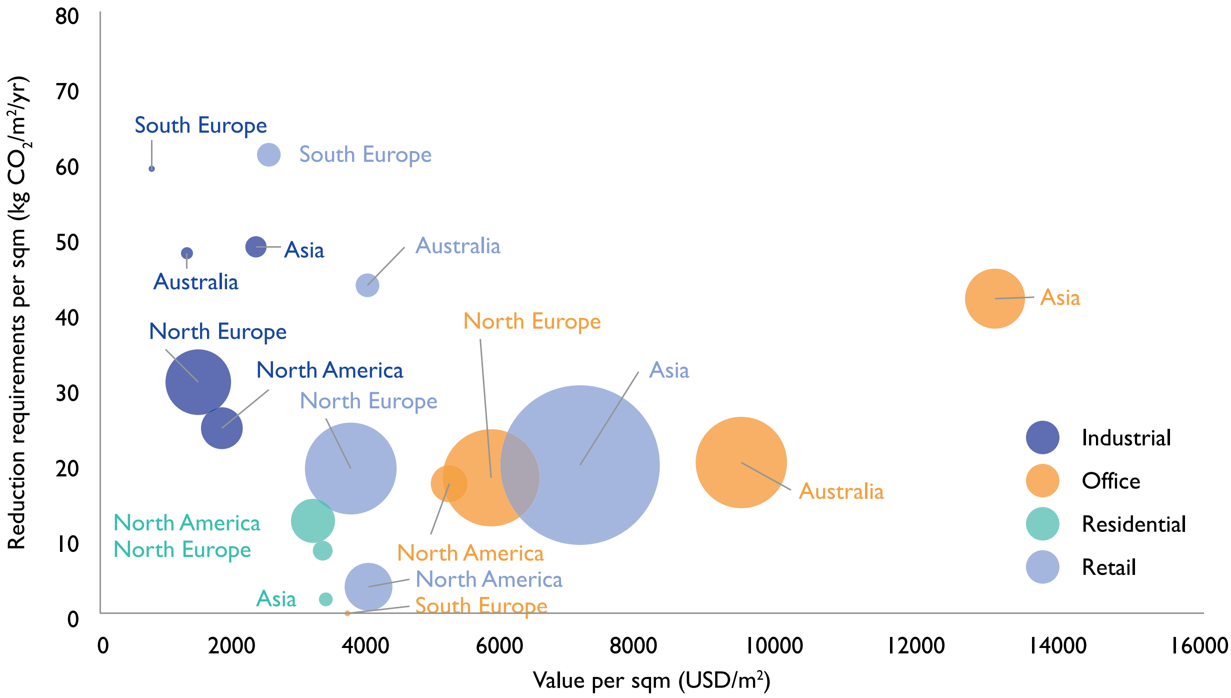



**Figure 11:** Reduction requirement per m2 as a function of average value property per geographic region and its building type, where the size of the bubble represents the market size.

Properties which have high reduction requirements and a low value per m² may be considered high risk: these properties could face high retrofitting costs that may be difficult to absorb considering the lower property value. Properties with low reduction requirements and high values may conversely be considered low risks. This risk correlation (low asset value and high reduction requirement) might however vary with deeper analysis of the costs associated with improving the carbon performance. Retrofitting for energy reductions and fuel/energy source switching can vary greatly in different geographical regions. This especially applies for labor costs, which are an important driver in the construction sector.

Industrial properties which generally have a lower value per m² are likely more vulnerable to costs which currently might not be priced in. The properties in South Europe, Australia and Asia can especially be considered high risks as they have relatively high reduction requirements. However, the market size is considerably low within the aggregated portfolio; overall, the costs might not substantially impact the financial performance of the portfolio.

The reduction requirement for office properties trend toward around 20 $kgCO_2/m^2/$ year, with Asian properties as an outlier that, on average, face reduction requirements of

45 kgCO$_2$/m$^2$/year. The valuation of these properties is on average higher than in the other markets, thus the associated costs may be absorbed better. Additionally, labor costs are generally lower in these markets which further reduces the risk.

Evident from the results presented in this section is the large spread within the portfolio both in terms of warming potential and policy risk. The spread of warming potential is seen for different building types as well as regions, influencing the portfolio temperature alignment. Furthermore, the analysis also shows that the high-risk assets can be skewed to certain regions and building types for the given portfolio. The insights, then, from a bottom-up perspective can provide valuable indicators to investors on the spread of the risk within a portfolio.

## 3.4. PHYSICAL RISK EXPOSURE

The physical risk in the model is composed of five hazards: Extreme Cold, Extreme Heat, Extreme Wind, Tropical Cyclones and Coastal Flooding. In addition to the combined risk of all the hazards, the result can be viewed per hazard and at the asset level. The analysis is based on: total number of days of exposure for Extreme Cold, Extreme Heat, and Extreme Wind; and for Tropical Cyclones and Coastal Flooding, the relative annual damage experienced by an asset. The latter two are based on a scale of high to low risk.

The following subsections present the regional average exposure of each of the five risk hazards, as well as the exposure of individual assets with the largest change in exposure for each region (i.e., the absolute difference between current and expected future exposure). The analysis further shows the potential additional cost to asset owners of addressing tropical cyclone and coastal flooding, respectively.

### 3.4.1. Exposure to Extreme Cold

Figure 12 presents the regional average of cold exposure days today and for future projections. Exposure in Australia and South Europe is insignificant, as the number of cold days is predicted to be low in those regions. More noteworthy is the projected decrease in the higher average exposure in Asia, North Europe, and North America. This could be considered a transition risk 'opportunity', although would naturally need to be balanced with the change in exposure from corresponding increases in extreme heat.

For a more granular understanding of value at risk, Figure 13 shows the asset which the largest change in exposure per region. For example, the analysis for Asia reveals a present and future average of less than 4 days exposure (Figure 12), but containing highly exposed individual assets (Figure 13), i.e. 75 days of exposure presently to 62 days projected. Similarly, large differences between the regional average and individual asset exposure appear for North Europe.

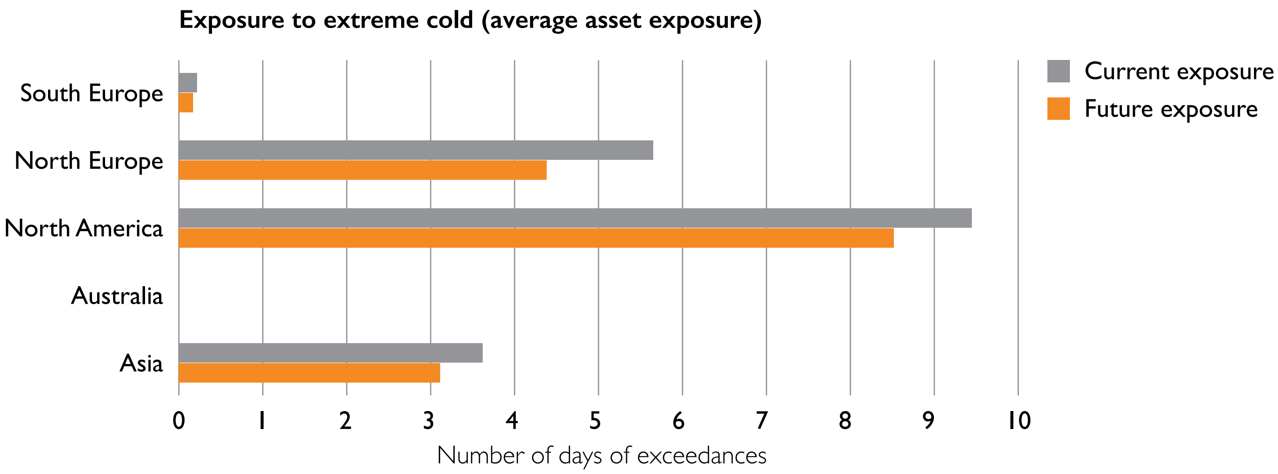



**Figure 12:** Regional exposure to Extreme Cold, expressed in number of days of exceedances.

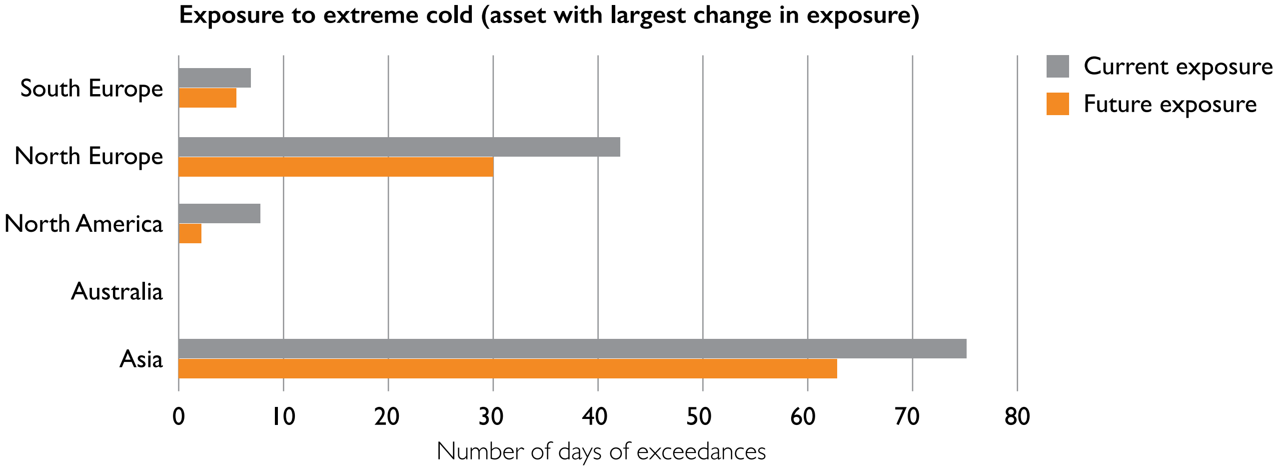



**Figure 13:** The asset in each region with the largest change in exposure to Extreme Cold, expressed in number of days of exceedances. Note the different scale on the x-axis compared to the Figure above.

### 3.4.2. Exposure to Extreme Heat

Using an analytical framework similar to the above for Extreme Cold, Figure 14 and Figure 15 present the Extreme Heat exposure and reveal that an increasing number of days with extreme heat is to be expected. In North America, the asset with the largest increase in exposure days goes from roughly 80 to 100 days (the average exposure days for North America is essentially half of the most extreme asset). Similar trends hold true for the other regions.

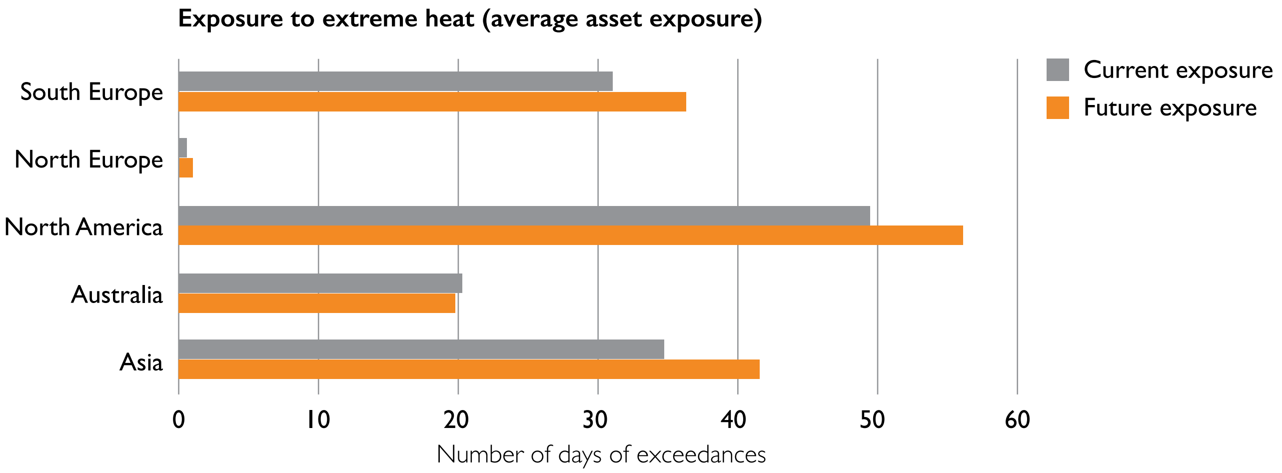



**Figure 14:** Regional exposure to Extreme Heat, expressed in number of days of exceedances.

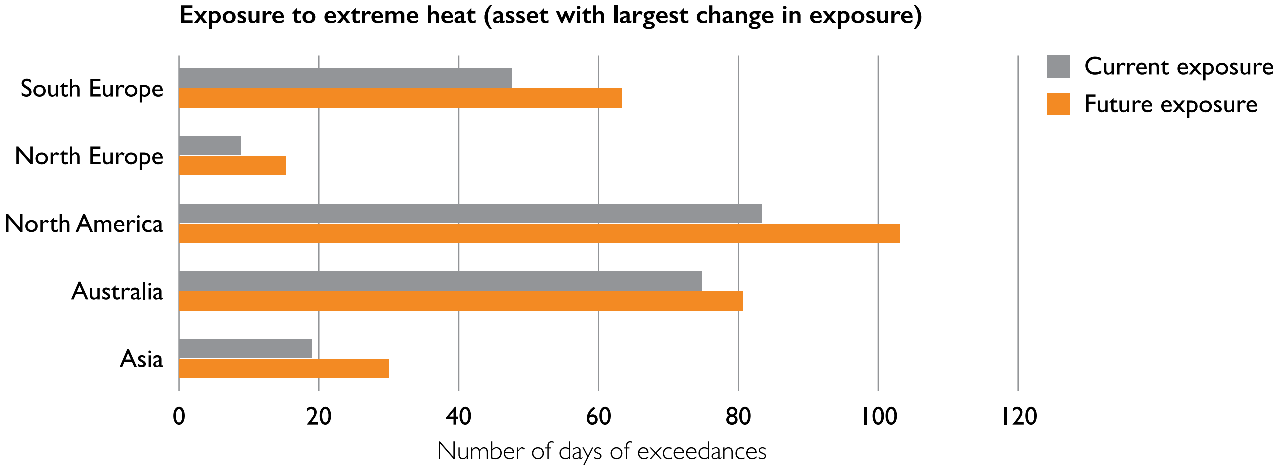



**Figure 15:** The asset in each region with the largest change in exposure to Extreme Heat, expressed in number of days of exceedances. Note the different scale on the x-axis compared to the Figure above.

### 3.4.3. Exposure to Extreme Wind

Extreme Wind, which excludes acute events such as tropical cyclones, is the hazard with least exposure across all regions. The average exposure is shown in Figure 16. The exposure in Australia is nominal, and very low in North America. North Europe is the region with the highest exposure for both the average and individual asset level. Furthermore, though North Europe has the highest current exposure, the exposure is projected to decrease, whereas for the other exposed regions it is projected to increase or remain the same. In Asia, there is a large difference between the low average value and the much higher single asset level exposure (Figure 17).

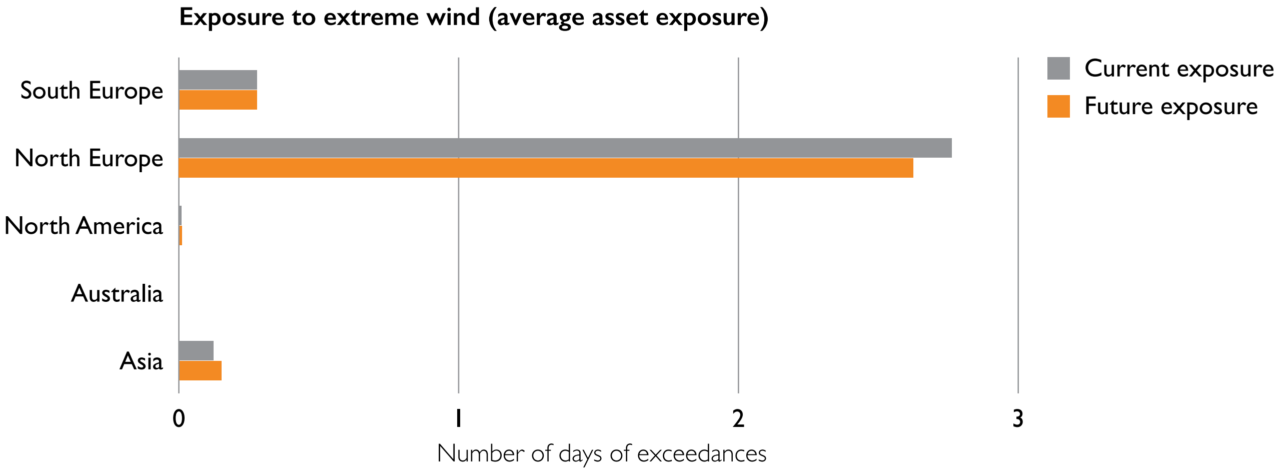



**Figure 16:** Regional exposure to Extreme Wind, expressed in number of days of exceedances

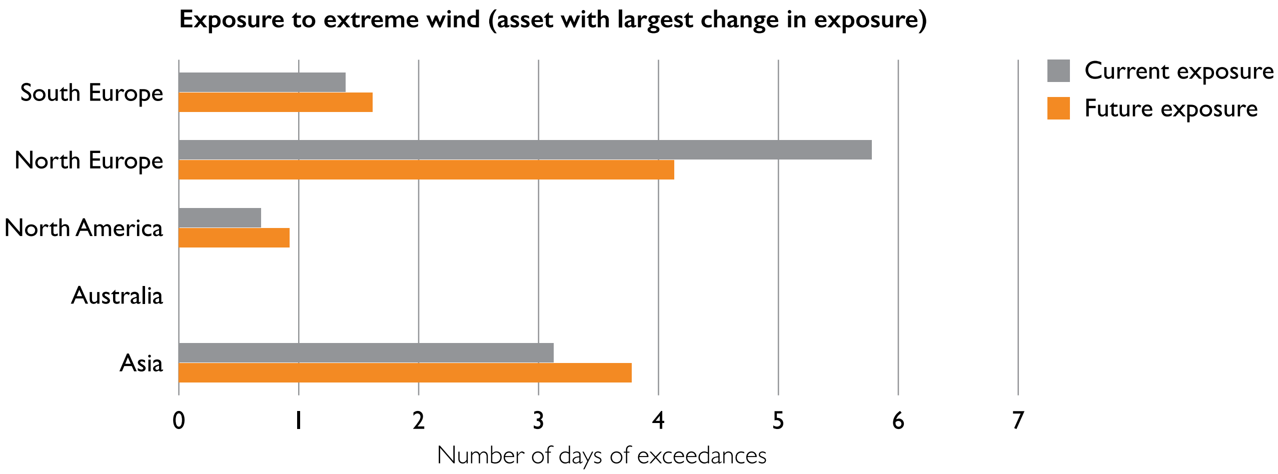



**Figure 17:** The asset in each region with the largest change in exposure to Extreme Wind, expressed in number of days of exceedances.

### 3.4.4. Exposure to Coastal Flooding

The assets contained within this sample portfolio are minimally exposed to coastal flooding[8] at present. Only 17 properties register exposure, largely concentrated in Northern Europe (United Kingdom and Netherlands), followed by Asia (Japan, Hong Kong) and then Australia and South Europe. No assets within this portfolio in North America are exposed. Modelling on the portfolio, however, suggests a significant increase in coastal flooding risk over the coming 15 years. This is further discussed in section 3.4.6.

### 3.4.5. Exposure to Tropical Cyclones

Figure 18 shows the average exposure for each region, followed by the asset with the largest change in exposure in Figure 19. However, since tropical cyclones are not measured by number of days of exposure, but instead as a relative risk of annual damage, they have thus been assigned a score of high to low risk.

For South and North Europe, the exposure is minimal both today and in the future due to their geographical position. However, for both North America and Asia, the risk is increasing. The difference between the present and future average exposure is slightly greater in North America than in Asia. At the single asset level, the analysis for Asia shows a reasonably high risk today and in the future. Comparatively in North America, the single asset analysis shows a lower present risk exposure but much greater future risk exposure (as well as greater difference between present and future risk).

8. The coastal flooding model includes a digital elevation model which estimates the level above sea of a given property based on the geo-location. The digital elevation model uses satellite data to compute the terrain's elevation. There are some challenges in creating very precise coastal flooding models and highly accurate risk quantum. For example, in areas with a high density of high-rise buildings, the elevation can be overestimated as the satellite might misinterpret the building's roofs as the Earth's surface. Additionally, precise geo-location is required for the coastal flooding modelling as the costs of coastal flooding are highly sensitive to proximity to water and can display significant differences over short distances.

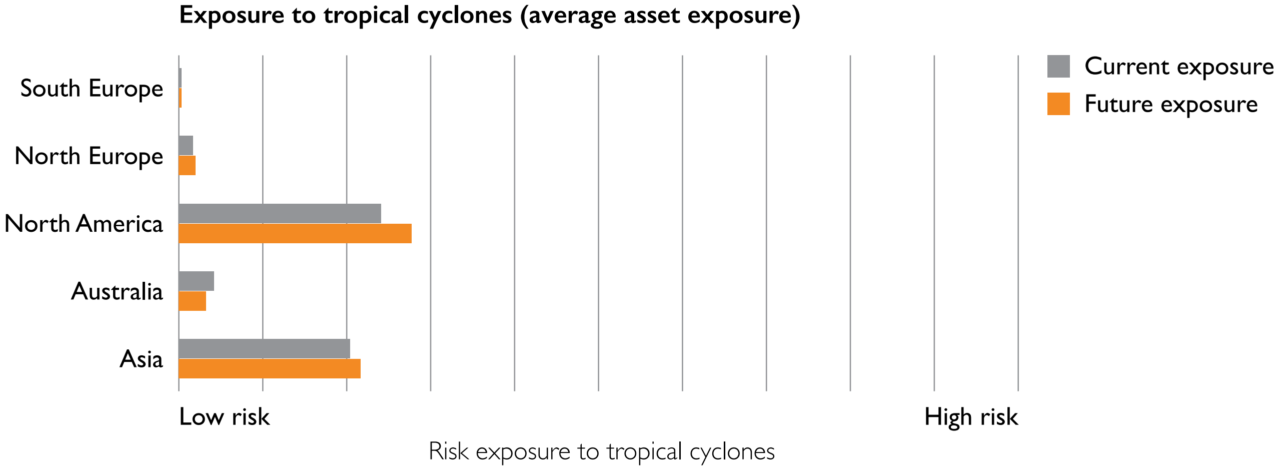



**Figure 18:** Regional average relative exposure to tropical cyclones, expressed on a scale from low to high risk.

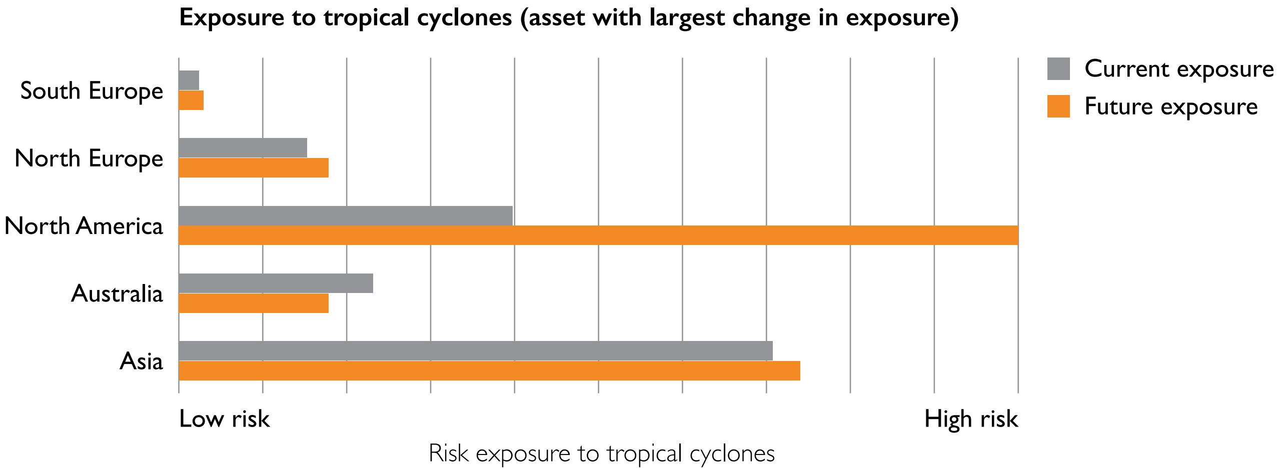



**Figure 19:** The asset in each region with the largest change in exposure to Tropical Cyclones, expressed on a scale from low to high risk.

## 3.4.6. Cost associated with Coastal Flooding and Tropical Cyclones

The analysis of all the exposure data reveals that the largest additional future costs are from coastal flooding and tropical cyclones. As mentioned in section 3.4.4 and 3.4.5, fewer assets are exposed to coastal flooding in comparison to tropical cyclones. However, this coastal flooding exposure represents the majority of the physical risk costs of the portfolio.

Figure 20 shows the additional cost associated with tropical cyclones by region for the next 15 years. Though North America has a higher future average and single asset exposure (Figure 18 and Figure 19), the risk and associated additional cost in Asia is significantly larger due to the market share of Asian properties in the portfolio. Since Australia is projected to face decreasing exposure to Tropical Cyclones, it does not face additional cost and is thus not included in the figure.

Figure 21 shows the additional costs from exposure to coastal flooding for the next 15 years. Though North Europe has a higher number of assets exposed, the Asian properties are at higher risk. (The modelling of the portfolio showed no North America assets exposed and therefore no costs are presented in the figure.)

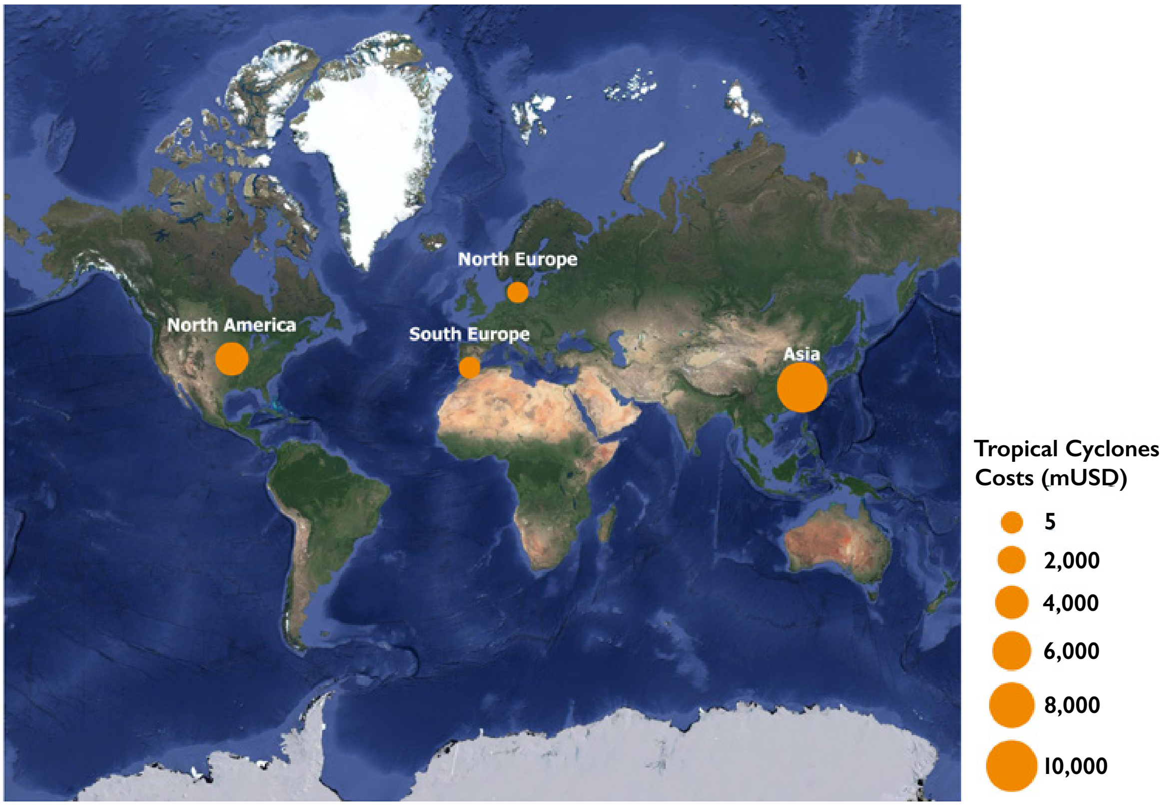



**Figure 20:** Additional cost associated to tropical cyclones for the geographical regions.

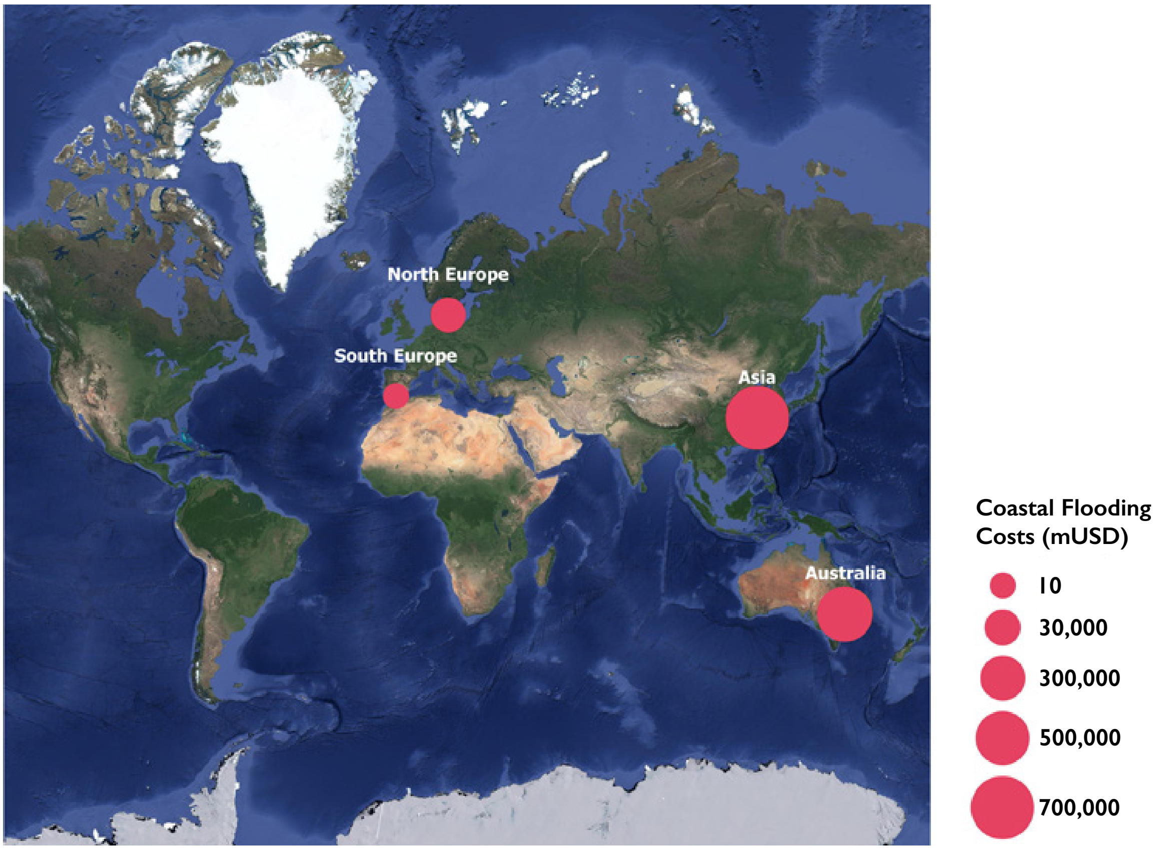



**Figure 21:** Additional cost associated to coastal flooding for the geographical regions.

Comparing Figure 20 and Figure 21 reveals the far larger value at risk from coastal flooding. Though the number of assets exposed in the portfolio exposed is lower, the total potential loss is 70 times higher than from tropical cyclones in the Asian region.

# 4. SUMMARY CONCLUSIONS

This pilot uses a basic model to assess real estate climate risks (transition and physical types of risk). The modelling shows that average climate value at risk over that period can appear relatively low. However, it **may be that the model underestimates long-term climate risks for several reasons:**

1. **The physical risk model uses historical observation to derive trends for the next 15 years whereas long term climate models predict greater impacts over a longer time horizon.** These risks over the next 15 years are already 'locked-in', meaning that independent of the mitigation actions taken the physical climate is going to change and costs related to physical hazards will likely increase.
2. It is expected **that physical risks—and accompanying damage—will become more significant towards the middle of the century** as temperatures rise and while most present assets are still expected to be in service.
3. **The physical risk hazards included in the model do not cover all potential hazards**—for instance, fluvial flooding or wildfire. These two prominent risk hazards are currently being developed and will be part of the next generation model. Widening the coverage of physical risk hazards is likely to increase the potential costs derived from physical risk.
4. **The risk analysis currently only captures direct impacts**, and not the indirect ones. For instance, there are reasons to believe that physical risk will impact economic growth and GDP (and transition risk in some geographies), which in return would cause indirect impacts on real estate investments. Moreover, the indirect impacts related to supply chain are also not included in the model as of today.
5. **A delayed carbon price rise may not adequately reflect the near-term cost of real estate retrofitting legislation.** The model uses simulated carbon prices from the PIK REMIND model that, broadly speaking, grow exponentially. This, coupled with an 8% financial discount rate, leads to a low modelled transition risk regardless of scenario. In reality, the cost of deep retrofits to meet incoming building efficiency regulations may be more substantial (although will lead to lower ongoing operational costs). There can also be concentrated risk in a portfolio despite a small average value.
6. **There are additional (often unintentional) impacts of the physical adaptation and transition initiatives that are likely to considerably affect the value of an asset.** Indeed, the differing local regulations and specifications that vary by (and sometimes within) countries make global models only a rough guide to the asset-level conditions.

Nonetheless, there remain several **ways that institutional real estate investors can use the data** produced by this model, such as:

1. From the transition risk side, the **warming potential is perhaps the most powerful tool that investors can use to understand how their assets and portfolio is benchmarked against global targets.** It can also be an influential communication element for simple and impactful reporting both internally and externally.
2. The underlying **transition risk values can also be used to assess the regions potentially at highest risk for the portfolio**—these can be inferred from those areas where the nationally defined reduction requirement is greatest and where the portfolio's highest value assets (or group of assets) are located, or where a low asset value might make retrofit costs difficult to absorb.
3. **From a physical risk perspective, while average risks can be low, certain buildings may be high risk from one or more hazards.** Assessing the outliers can allow investors to mitigate risks for particular assets by ensuring that building design is fit-for-purpose; transferring the risk through insurance; or, at the extreme, offloading the risk by selling the asset.

**The fundamental purpose of the pilot was as an innovation and learning exercise, and it has supported real estate investors in financially quantifying the climate risk in their real estate portfolio, often for the first time.** There have also been some significant learnings from the project. For instance, availability of real estate data is often limited and the models available that can support climate risk analysis need to account for this data availability and quality. Even asset owners themselves often lack granular data like energy efficiency or emissions data on their own properties. This can impact accuracy.

**Moving forward, there are several enhancements Carbon Delta intends to make to the model to build upon the current version as described in this report.** For instance, the time horizon will be extended to 2050 and several additional scenarios will be provided to help with TCFD reporting and other analyses. Physical hazards such as fluvial flooding and wildfires will be introduced and increasing the resolution of the model will be done continuously through migration to the newest and most powerful updates to the underlying climate models. The transition risk analysis will see additional dimensions such as pass-through costs and tenancy risk added to the core transition model. In addition, an increase in the granularity of the sectoral breakdown will allow for a more realistic building type model, and the introduction of other sustainability and more traditional real estate datasets will further improve the sophistication of the model. Finally, the ability to view the data in a graphical user interface will help the user intuitively assess their climate risks and help communication within organisations.

# CASE STUDIES

## A BRIEF INTRODUCTION TO AVIVA

Aviva is an asset owner, an insurer, and an asset manager. Aviva has real-estate exposure in the form of direct property investments and holdings as well as real-estate linked exposure in the form of commercial and residential mortgages.

Aviva has committed to implement the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) including conducting climate-related scenario analysis and we have reported on these recommendations since 2016.

Aviva joined the UNEP FI Real Estate Pilot project to support the development of consistent and comparable high-level scenarios (including common elements regarding the modelling of the impact of physical and transition risk) with other insurers and asset owners.

## AVIVA'S CLIMATE RISK SCENARIO ANALYSIS

Aviva's Chief Risk Officer and the Group General Counsel and Company Secretary are the executive sponsors overseeing our disclosures. However, other group executives and local markets are responsible for specific areas of the business which may impact or be impacted by climate change: insurance, asset management, operations and finance.

In 2018 Aviva initiated a project to create best in class climate related scenario analysis capability to enhance our disclosure. The project covers the identification of appropriate climate related scenarios, assessment of those scenarios and development of reporting formats for the results of the scenario analysis. During 2019 further enhancements to the modelling have been made.

An inter-disciplinary team with input from Aviva's Public Policy, Group Risk, Group Capital, Asset management, Group Reinsurance and Business Units was created to manage the project day-to-day and an expert panel was also constituted to support the project by reviewing and challenging the main assumptions made in the selection, development and modelling of the scenarios. On the expert panel we have representation from Aviva's Real Assets team that manage our real estate portfolios.

## INCLUSION OF MORE AGGRESSIVE PHYSICAL RISK SCENARIO

When determining the scenarios to apply to climate risk modeling, one of the main challenges we identified as part of the project was whether a more aggressive physical risk scenario should be included in the scenario analysis. Under the IPCC Business-as-usual scenario (RCP 8.5), which assumes emissions keep rising at current levels, it is considered as likely as not that the global average temperature rise from pre-industrial levels will exceed 4 degrees by the end of the century and it is highly likely in this scenario that temperatures exceed 3.5 degrees.

Thus, a more aggressive physical scenario, of say 6 degrees Celsius, is plausible by 2100, particularly when the risk of climate tipping points being reached causing runaway warming is factored in. However as can be seen from the graph below, the worst physical effects are only likely to manifest themselves in the second half of the century and in the short to medium term there is relatively little difference in temperature rises between each IPCC scenario.

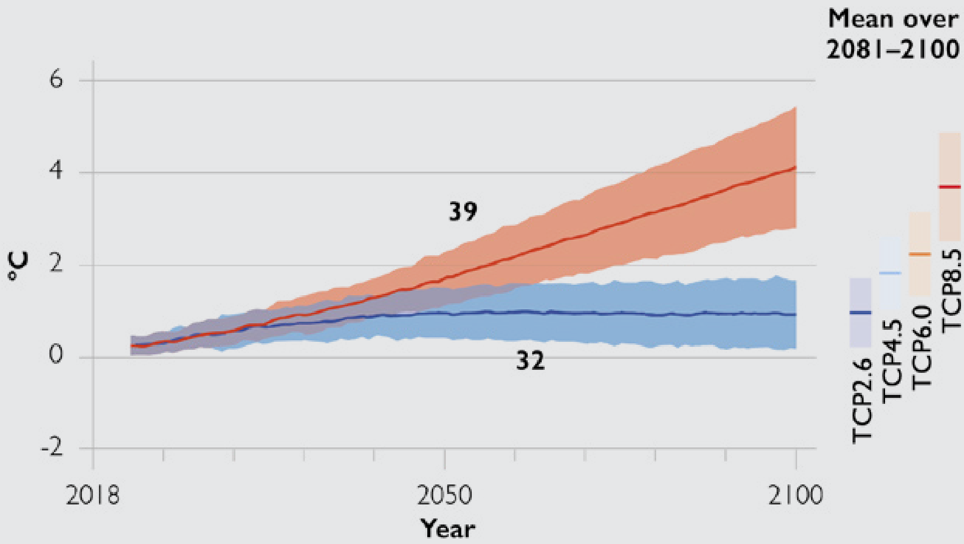



**Figure 22:** Global average surface temperature changes relative to 1986–2005

In contrast the effects from the transition to a low carbon economy are likely to be felt over a much shorter time-frame and to differ considerably between each IPCC scenario. As a result, if scenario analysis is conducted over relatively short-time horizons then the differences in the long-term impact of physical risk in each scenario as well as the level of physical risk compared to transition risk in each scenario could be understated and as a result, inappropriate conclusions drawn about the impact on direct real estate and real-estate linked investments.

That said, if physical and transition risks are not being looked at consistently then it makes it more difficult to understand the combined effect of the aggregate risk in different scenarios, as tackling mitigation and adaptation challenges present a number of trade-offs. Furthermore, it could be argued that the longer the time horizon used for the scenario analysis, the less decision-useful it becomes. To address these points, it was agreed within the UNEPFI pilot group and with the project's consultant, Carbon Delta, to use a consistent 15-year time horizon, with the ability to look at shorter time periods, for both transition and physical risk, but to capture more aggressive physical risks by looking at a higher, 95% percentile of historical extreme weather observations, as well as the expected outcome under an "average" BAU development scenario. See figure below for example of coastal flooding.

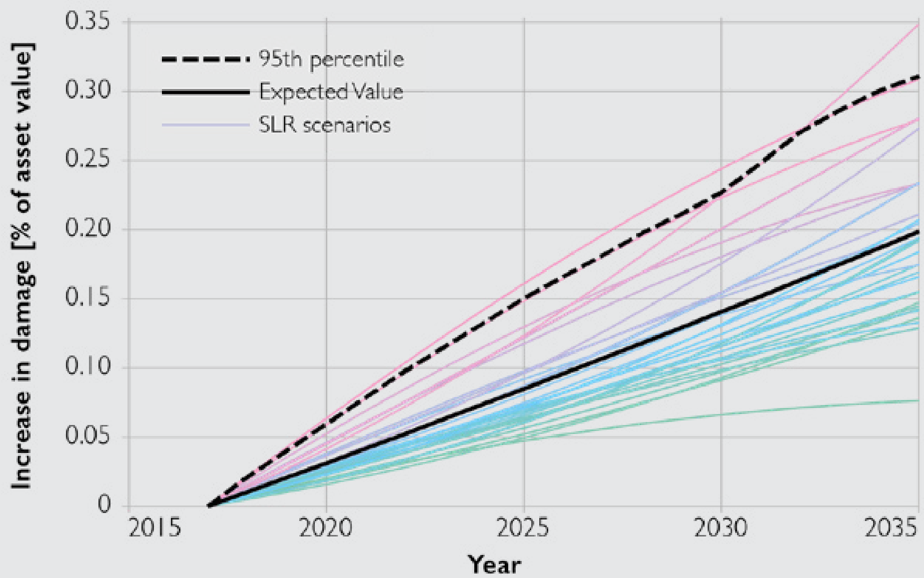



**Figure 23:** Increase in damages as % of asset value from expected value to 95th percentile for coastal flooding

To analyse a more aggressive physical risk scenario, at a higher, 95% confidence level, risk datasets were compiled for each hazard. The hazards that Carbon Delta modeled include: extreme heat and cold, coastal flooding, wind storms and tropical cyclones. In addition, unlike in the expected case, a dependence structure was defined between hazards.

The figure below shows, based on output from Carbon Delta, the difference when estimating impact when looking at the "Aggressive" (95% percentile) scenario compared to expected outcomes under a "Average" BAU scenario based on the real estate holdings of the UNEP FI asset owners pilot group, separated by hazard. Note that Carbon Delta do model Extreme Heat, Extreme Cold and Extreme Wind but the impact on this portfolio was small compared to Coastal flooding and Tropical cyclones. In the more aggressive physical risk scenario, the overall risk increases by around one third compared to the expected scenario.

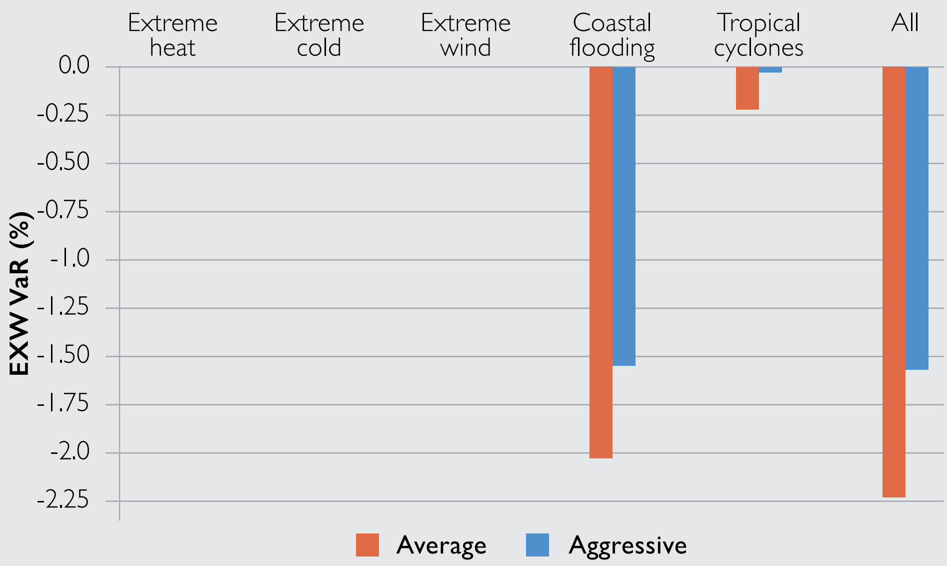



**Figure 24:** Aviva analysis of differences between average and aggressive scenarios across physical hazards

## CONCLUSION

The introduction of a more aggressive physical risk scenario by Carbon Delta enables the potential impact of more extreme physical risk outcomes to be assessed over a decision-useful, consistent and comparable timeframe as that used for transition risks. However, we recognize, that there is still further work to do to refine this methodology, including potentially introducing more long-term, sophisticated scenarios, which could reveal some of the variability in outcomes indicated by climate models. Carbon Delta are also planning to introduce further perils to cover a greater breadth of physical risks. Before this is done the model remains sensitive to assumptions made about growth of physical costs beyond 15 years.

It is particularly important to understand the potential impact of various outcomes when aggregating physical risks with transition risks under different scenarios or simply comparing the impact of different scenarios. For example, one would expect that the costs of physical risks in the BAU scenario to grow much more rapidly than in the IPCC's ambitious mitigation scenario (RCP 2.6). Carbon Delta currently offers nine transition risk scenarios yet only two physical risk scenarios. A more proportionate number of physical risk scenarios could be developed to couple with the various transition risk scenarios. We would recommend making adjustments to the outputs to take account of this imbalance. In addition, we would expect the modelling of dependencies between hazards to be refined further over time.

CBRE GLOBAL INVESTORS

## ABOUT CBRE GLOBAL INVESTORS

CBRE Global Investors is a global real asset investment management firm with $106.7 billion in assets under management[9] as of June 30, 2019. The firm sponsors investment programs across the risk/return spectrum for investors worldwide.

CBRE Global Investors is an independently operated affiliate of CBRE Group, Inc. (NYSE:CBRE). The firm harnesses the research, investment sourcing and other resources of the world's largest commercial real estate services and investment firm (based on 2018 revenue) for the benefit of its investors.

CBRE Global Investors' investments range is diverse:

- Direct investment in commercial real estate through separate accounts or private pooled funds. Asset classes include office, retail, logistics/industrial, residential and niche.
- Direct private investment in infrastructure including energy, transportation, telecommunications, data storage and water facilities
- Indirect investment in commercial real estate through private funds and vehicles with proven operating partners.
- Investment in commercial real estate through publicly listed securities.
- Investment in infrastructure through publicly-listed securities.
- Private equity through well-diversified global portfolios that exposed to multiple strategies such as buyout, growth, distressed and venture, or narrow strategies that focus on only one of these investment styles.

CBRE Global Investors is committed to The Investors Agenda - Investors Disclosure Area of Impact and disclosure in line with the recommendations of the Financial Stability Board's Task Force for Climate-Related Financial Disclosures ("TCFD"). Disclosure already includes participation in the pilot reporting based on TCFD recommendations through the 2018 and 2019 Principles for Responsible Investment ("PRI") reporting framework and Global Real Estate Sustainability Benchmark ("GRESB") Resilience Module.

## CBRE GLOBAL INVESTORS' TCFD ALIGNMENT PROJECT

CBRE Global Investors' programme to report and act in line with TCFD recommendations is led by the Global Head of ESG, overseen by the Global Responsible Investment Management Committee ("RIMCo") and sponsored at the executive level by the Global Chief Operating Officer and Global Chief Investment Officer.

CBRE Global Investors designed its overall approach to TCFD alignment in two main phases (Figure 25).

9. Assets under management ("AUM") refers to the fair market value of real asset-related investments with respect to which CBRE Global Investors provides, on a global basis, oversight, investment management services and other advice and which generally consist of investments in real assets; equity in funds and joint ventures; securities portfolios; operating companies and real asset-related loans. This AUM is intended principally to reflect the extent of CBRE Global Investors' presence in the global real asset market, and its calculation of AUM may differ from the calculations of other asset managers

Phase 1 started in 2018 and is targeted for completion by the end of 2019. This phase covers initiatives to:

1. Undertake an internal governance gap analysis of existing risk governance and implement any amendments, and
2. Identify the most comprehensive tools and approaches to conduct portfolio scenario analyses of risks and opportunities and develop a climate-change value-at-risk heat map.

The next phase, commencing in 2020, with a completion deadline in 2022, envisages full integration of climate-change scenario analysis in the due diligence process, 'deep-dive' analysis of high-risk assets identified through scenario mapping, integration of mitigation actions and cost assessments in asset business plans and transparent reporting. Climate change analysis is thus to be explicitly included across the investment process. For the indirect business, targeted engagement will be undertaken with managers and companies to promote adoption and implementation of carbon targets, and enhanced reporting.

Finally, the Phase 3 target is to achieve a full alignment with TCFD guidelines in the CBRE Global Investors ESG Report to be published in 2023.

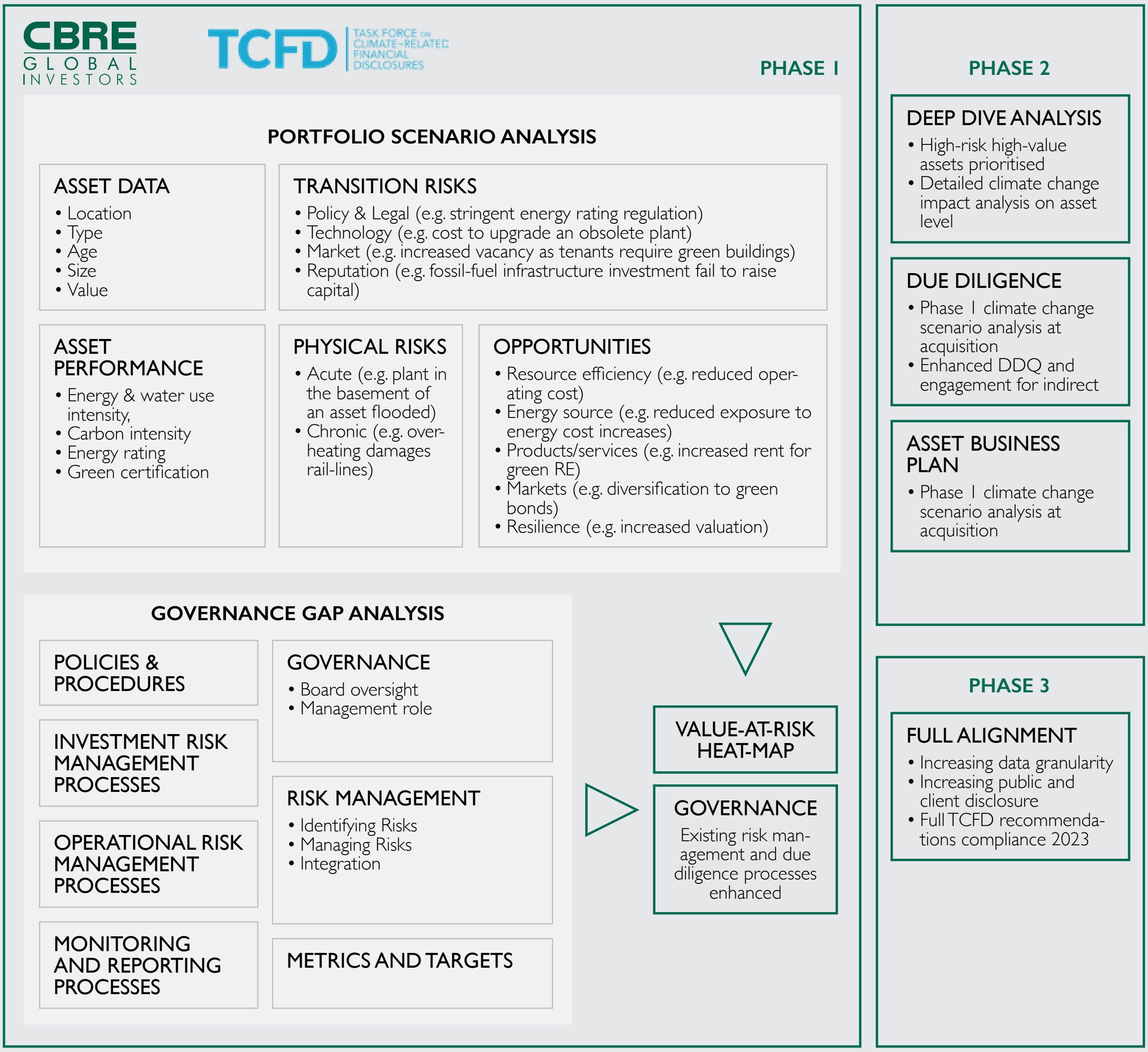



**Figure 25:** CBRE Global Investors TCFD alignment project

## GOVERNANCE GAP ANALYSIS

Underpinning the implementation process of fully aligning with TCFD recommendations is the complete understanding of current policies and practices.

CBRE Global Investors considered the gap analysis to be an opportunity to review all relevant policies, practices and reporting standards, and was important in identifying areas for improvement. The CBRE Global Investors approach involved a thorough review of all relevant documents and practices, as well as structured and semi-structured interviews with key employees within each business area.

The result was a complete overview of the current processes against TCFD recommendations for Governance, Risk Management, and Metrics and Targets for each region and business area. Engaging with employees at all levels of the company, from fund managers to corporate executives enabled an open communication channel about climate change and generated significant interest from employees.

Continuing the conversations with each business line, the findings from the gap analysis were used as a foundation to further discuss how to best bridge the gaps and fully align with the TCFD recommendations.

The next step was then to identify the key policies, documents and practices in which climate-related issues should be integrated and collaborate with the original authors on executing the updates.

CBRE Global Investors is now moving into Phase 2 of the TCFD alignment process when the scenario analyses and gap analysis results will be merged.

## PORTFOLIO SCENARIO ANALYSIS

The initial aim at the start of Phase 1 was to identify a comprehensive scenario analysis tool applicable to all investment strategies and asset types. However, there are no such products currently on the market.

CBRE Global Investors conducted an independent market check of the climate change-related risk and opportunities scenario analysis options. Selection criteria included scenarios and time range used, data sources, and range of risks and opportunities for physical and transitional impacts of climate change, implementation readiness and cost.

In addition, CBRE Global Investors has participated in the pilot development of the EU-funded research project, Carbon Risk Real Estate Monitor ("CRREM"), focusing on the transitional risk of asset stranding due to increasing building energy efficiency regulations.

The Carbon Delta approach was selected as the most comprehensive tool available for real estate investments, which is semi-automated and covers both physical and transitional aspects of climate change-related risks and opportunities. The findings from the pilot phase will also be used by the firm's indirect business to engage underlying fund managers and operating partners.

At the time of this writing, there is no such tool applicable to infrastructure investments. CBRE Global Investors is in process of joining the Coalition for Climate Resilient Investment ("CCRI") which aims to develop, among others, a systemic resilience assessment tool and resilient asset design and structuring tool.

## CARBON DELTA PILOT

CBRE Global Investors has conducted a pilot testing of a virtual portfolio of 60 assets, formed of 20 real estate assets in each of the key regions: the U.S., APAC and EMEA. The assets belong to a range of commingled funds, separate accounts and joint ventures, and span all key types: office, retail, logistics and residential.

The importance of the availability and accuracy of asset performance data has quickly been identified as a critical component for the pilot's success. Assessment of an asset's resilience based on the national averages for energy efficiency results in a very high-level mapping of its risks. This approach did not provide sufficient information to identify assets for the next 'deep dive' phase as per the TCFD alignment project. For this reason, additional data were collected, checked and the pilot mapping re-run.

The Carbon Delta report expresses risks as the percentage of asset value at risk. While valuable, this information on its own is not easy to comprehend for the non-specialist fund and asset managers. The primary purpose of Carbon Delta mapping for CBRE Global Investors' assets is to identify the 'heat' zones of high risk and value. The initial testing of bubble-chart representation (Figure 26) shows assets mapped on X and Y axes for transitional and physical risk, respectively, with the bubble size representing the asset's value.

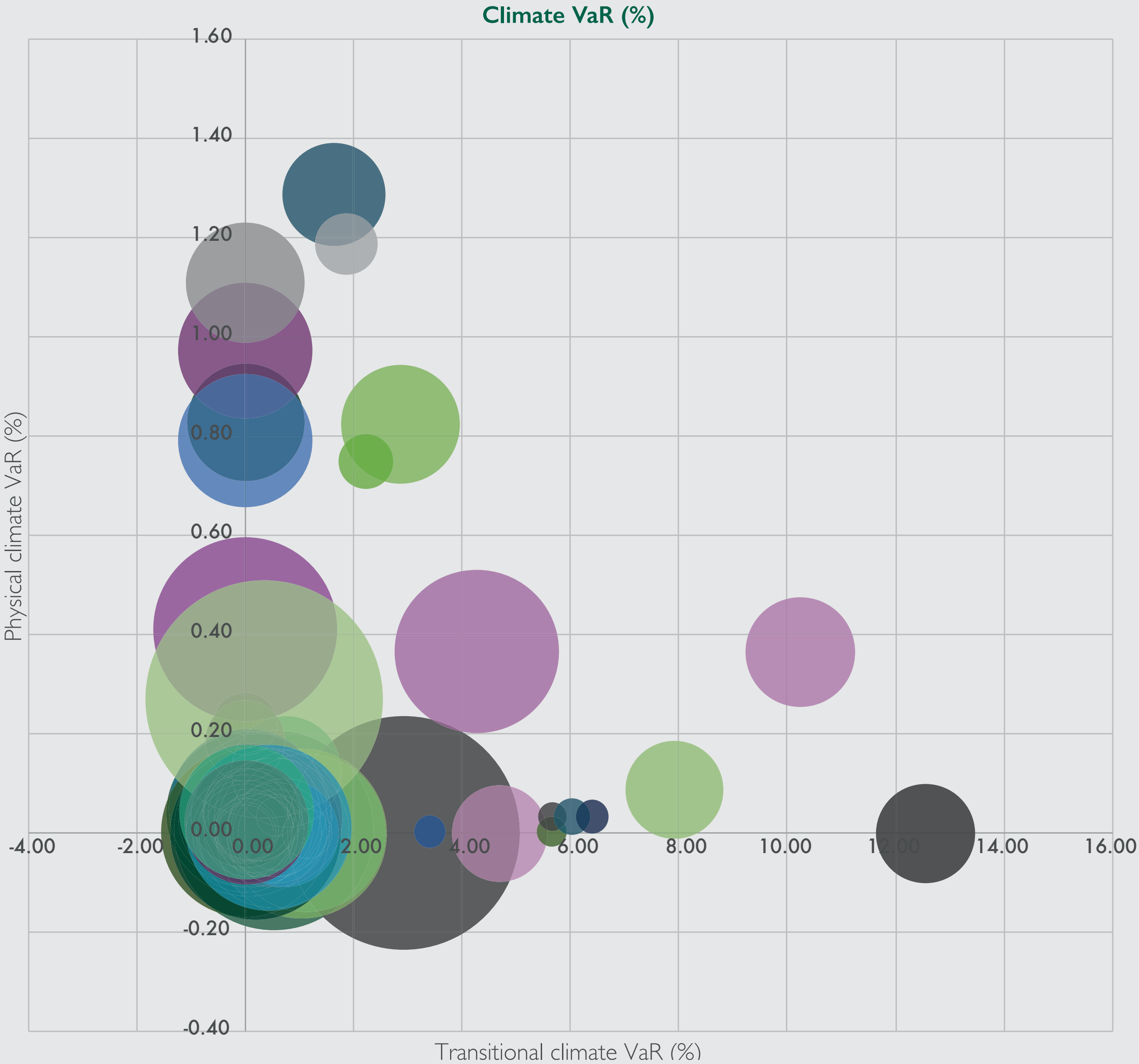



**Figure 26:** Pilot Bubble Chart for CBRE Global Investors' assets using Carbon Delta climate-related risks mapping data

## NEXT STEPS

The pilot process highlighted the need for high-quality environmental performance data. CBRE Global Investors had already adopted an ESG data management system called Measurabl. Its roll-out is nearing completion in EMEA, followed by the U.S. and APAC region. Wherever possible, automated energy, water and waste data feeds are established. The tool further enables normalization of performance data according to weather patterns, occupancy, asset type, location and age. This will enable more accurate mapping of transitional risks, and the results will be fed back into the platform for tracking and reporting on risk mitigation progress.

## EXECUTIVE SUMMARY

Working in conjunction with the UNEP FI Real Estate Working Group, Investa assessed its portfolio of 28 commercial office towers against various climate change scenarios, assessing the physical and transitional risks posed by climate change.

The results, detailed below, list the key material climate risks identified, as well as the associated financial exposures.

Investa's portfolio is well positioned to mitigate the transitional risks identified, whilst more work is required to assess the physical risks (most notably fluvial flooding and heat waves) posed to the assessed portfolio.

## INTRODUCTION: INVESTA AND CLIMATE RISK

As a long-term owner and manager of commercial office buildings in Australia, the resilience of our cities and the life systems Investa relies on like public transport and healthcare are of key material operational risk to Investa.

Since 2012, Investa has been working with the Australian Business Roundtable for Disaster Resilience and Safer Communities to drive awareness in the property sector for awareness of resilience risk, and necessary mitigation investment. As Investa's carbon reduction strategy 'Getting to Zero' articulates, Investa aims to expand our boundary of influence to include investors and our broader community.

Pleasingly, the TCFD work will enable a direct dialogue around the resiliency of real assets and ultimately the associated financial exposures. During FY18, Investa engaged investors directly to gauge expectation and best practice approaches to TCFD reporting. Reflective of this feedback, the response strategy is divided into three separable chapters to be commissioned over three years.

The initial phase of work identified key material risks and opportunities across the portfolio, followed by the second which has been developed in conjunction with the UNEPFI Real Estate Working Group, assessing climate change scenarios of key material risks and associated financial exposures. The final phase of work will be embedding key insights into investor reporting with financial risks and opportunities, as well as steps taken to mitigate and seize them, disclosed to investors in alignment with the TCFD's recommendations.

This case study represents the second phase of work, assessing climate change scenarios of key material risks and the associated financial exposures, performed in conjunction with the UNEPFI Real Estate Working Group.

## QUANTIFYING CLIMATE RISK

To ensure the maximum benefit from insights gained from the programme, Investa submitted 100% of assets under ownership and management to the UNEPFI analysis.

This is in recognition of the fact that climate change poses a risk to the whole Investa portfolio, rather than particularly vulnerable outlying assets. Assets included are in Sydney, Brisbane, Melbourne, Perth and Canberra.

Investa's proud history of climate change and carbon reporting has been to include all assets, irrespective of performance, in annual environmental performance reporting, which has been carried out since 2004. Over this time-period Investa has reported a 61% reduction in carbon emissions intensity, a tremendous outcome which demonstrates Investa's ability to actively mitigate the climate impact of its portfolio.

## Investa is well placed to achieve the 1.5° reduction requirements

In 2016, Investa set a carbon reduction target of net zero carbon emissions by 2040.

Pleasingly, Investa's excellent track record of monitoring and managing carbon mission performance has resulted in the portfolio being well placed to respond to the transitional risks posed by climate change. This is best quantified when considering that Investa's certified Science Based Target of net zero emissions by 2040 is targeting a portfolio wide emissions intensity of 20.72 kg.$CO_2$/sqm/yr by 2033, well within the range defined by the 3° and 2° scenarios, as shown in Figure 27 below.

Mapping the (linear) reductions required to meet the target emissions level by 2033 under the 3°, 2° and 1.5° scenarios for the whole portfolio (as shown in Figure 27 below), illustrates that with a continued 4% annual emission reduction trajectory, (consistent with historical reductions), Investa's portfolio is well placed to make these reductions.

Investa's confidence that such emissions reductions can be achieved stems from historical outperformance of similar trajectories. Since setting the Net Zero by 2040 target in 2015, the Investa portfolio is presently (2018 dataset) 1.6% ahead of the required emissions reductions required to meet this target.

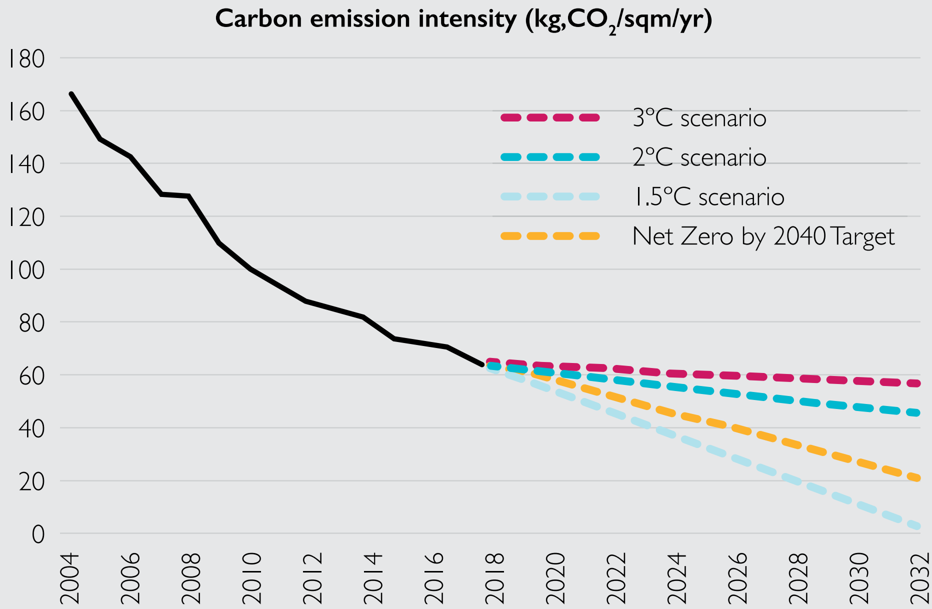



**Figure 27:** Historical emissions performance (2004-2018) and projected emissions trajectories under various scenarios

Given Investa's portfolio is tracking ahead of the transitional risk posed by the 3° and 2° scenarios, the greatest transitional risk is posed by a 1.5° future.

Across the 28 assets submitted to the assessment, 0.21% of total value was deemed to be at risk in the 1.5° scenario. Note, this quantified risk represents exclusively the transitional risks posed by a 1.5° scenario, not the physical climate risks.

Not surprisingly, these transitional transition risks (posed by increased legislative or regulatory pressure to comply with various carbon reduction scenarios) are most keenly felt by older assets in Investa's portfolio. This is because these assets possess older forms of building technology and as a result are not as energy efficient (and carbon efficient) as newer assets.

85% of the total value at risk under the 1.5° scenario (0.211% of total GAV) stems from older assets within Investa's portfolio.

Considering this, steps have still been taken to ensure that the risk exposure to these older assets is mitigated.

The two most emissions intensive assets in the portfolio, 120 Collins St and 242 Exhibition St, both in Melbourne, present primary examples of the work down to mitigate these risks. These assets' $CO_2$ current annual emissions are 84.4kg.$CO_2$/sqm/yr and 85.93 kg.$CO_2$/sqm/yr, well in excess of the present day portfolio average of 59.9 kg.$CO_2$/sqm/yr.

During FY17, these two iconic 25-year-old buildings, recorded 11% and 10% reductions in electricity consumption, leading to emissions reductions of 18% and 14% respectively. This led to 120 Collins Street achieving a 4.0 Star NABERS Energy Rating (Federally mandated ratings measuring energy efficiency), up from 2.5 Stars in 2014. Meanwhile, the specialist property management team at 242 Exhibition Street executed proactive efficiency projects including replacing all tenancy and back of house lighting with energy efficient LEDs. In the coming year, all stairwells, carparks and service areas will also be converted to LED lighting, which will result in reduced maintenance costs. This is the practical implementation of climate risk mitigation carried out by Investa's dedicated, on site specialist property management teams.

Initiatives such as these have seen the two assets register 42% and 29% emissions reductions over the past two years, as shown in Figure 28 below. Whilst these two assets are the two most carbon intensive in the portfolio, if the specialist property management teams can continue this progress towards the 2033 horizon of the scenario analysis modelled, the transitional risks posed by a 1.5° future will be mitigated.

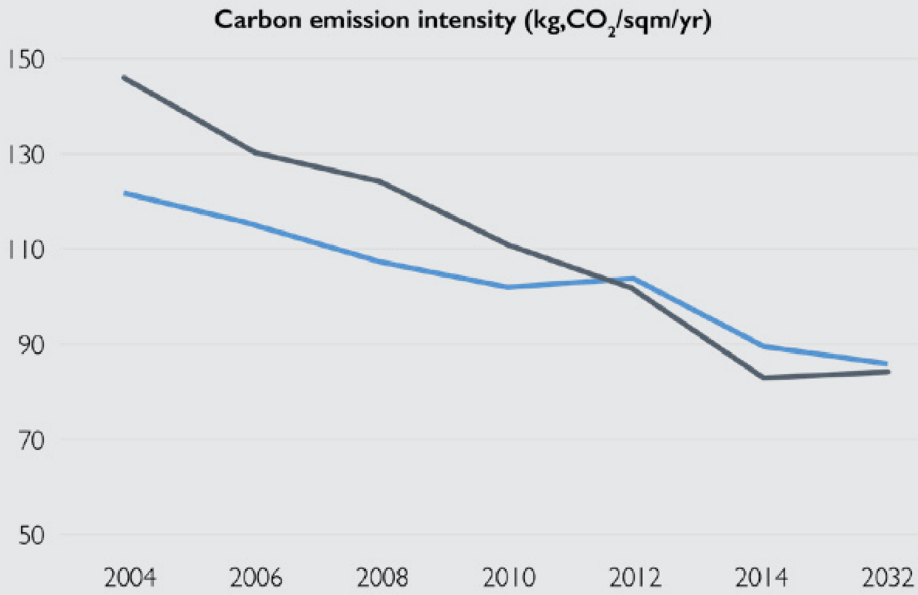



**Figure 28:** Carbon emissions reductions at 120 Collins St and 242 Exhibition St from the period FY12–FY18

## Transitional Risk Model Enhancements

A potential enhancement to the modelling of transitional risks would be the inclusion of scope 3 emissions in Carbon Delta's analysis. Scope 3 emissions are more complicated to measure, and harder still to reduce, however, real action on climate change requires vigilance around the total operational carbon footprint. The Science Based Target Initiative sector-based approach required the measurement and reduction of Scope 3 emissions to achieve an approved target.

Investa will continue to monitor and work with key stakeholders (including tenants, industry bodies such as the Green Building Council of Australia and international bodies including the Global Real Estate Sustainability Benchmark (GRESB) and the Science Based Targets initiative) to reduce the portfolio's scope 3 emissions.

## Location of assets

In addition to the age of assets, the other factor which influenced susceptibility to the transitional risks of climate change is location. Geographical differences provide two important distinctions;

The local climate determines the work required to condition the asset's indoor environment, with the heat of summer and winter cold experienced to different degrees in different Australian cities. In addition, natural hazards differ acutely between cities, requiring a varying suite of mitigation measures. Brisbane experiences cyclones and flooding, Sydney weathers severe storm events, where Melbourne will experience extreme heat waves. The Scenario Analysis has demonstrated that impact of the contrasting meteorological context has an immediate impact on value at risk.

Beyond just climate context, the local energy grid also demonstrated a variance in value at risk. The composition of the state energy grid determines the carbon intensity of the assets which draw their energy from the local grid. This is due to differing energy generating capacity between states with some states more dependent on high carbon sources of energy, whilst others have more renewable energy in the mix. These calculations are made by the Australian Federal Government's Department of Environment whose annual National Greenhouse Accounting (NGA) Factors determine the calculation of carbon intensities of Investa's buildings. The latest NGA factors, used to calculate the emissions profile of the portfolio, are provided below in Table 3.

| | Sydney | Brisbane | Melbourne | Perth |
|---|---|---|---|---|
| Emissions factor (kg.$CO_2$-e/kWh) | 0.83 | 0.79 | 1.08 | 0.70 |
| Amount of assets | 16 | 6 | 3 | 3 |

**Table 3:** National Greenhouse Accounting factors across Australian cities where Investa's portfolio is situated

The impact of NGA factors is highlighted when comparing three assets across the portfolio; 120 Collins St, Melbourne, 242 Exhibition St, Melbourne and 250 St Georges Tce, Perth. These three assets share similar characteristics, they are the three largest assets considered by Carbon Delta by NLA, all in excess of 60,000sqm and are considered 'Premium' or 'A' Grade according to the Property Council of Australia's classification.

Due to the differences in NGA factors, relatively small differences in energy consumption result in larger discrepancies when comparing emissions profiles and larger differences still when considering the modelled value at risk in a 1.5° scenario.

**Comparison between Melbourne and Perth assets, values given as a % of 120 Collins St results**

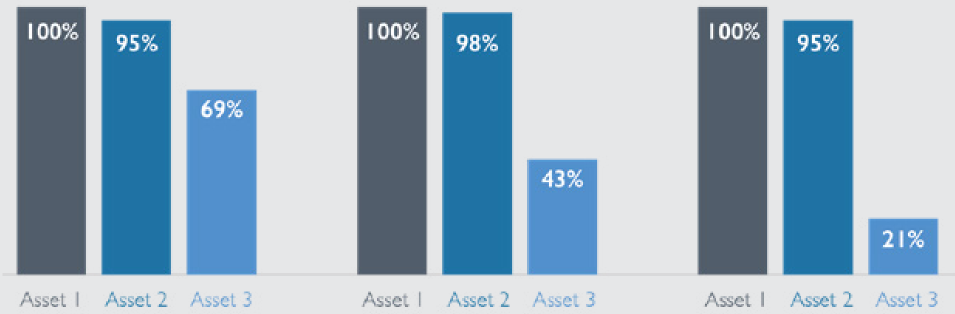



**Figure 29:** Variance between energy intensity, emission intensity and value at risk across geographical differences

This speaks to the need to assess the geography of investments when considering asset acquisition and divestment.

Further, given the nature of the energy grid (and in instances where assets are unable to generate power on site, which is very difficult for commercial assets with limited scope for rooftop solar) energy advocacy has an important role to play. Individual state's commitment to renewable and low carbon sources of energy plays a role in reducing the transitional climate risk posed to assets within their geographical boundaries.

For example, two assets with similar energy intensities (yet significantly different emissions intensities) are shown below in Table 4.

| | Energy intensity (kWh/sqm/yr) | Emissions intensity (kg.$CO_2$/sqm/yr) |
|---|---|---|
| 222 Pitt St, Sydney | 101.99 | 65.53 |
| 242 Exhibition St, Melbourne | 102.43 | 85.93 |

**Table 4:** Variance between energy intensity and emissions intensity across geographical differences

For this reason, Investa will continue important advocacy work, through industry bodies such as the Property Council of Australia, encouraging both State and Federal Governments to commit to stable energy policy, integrating climate policy and reducing the carbon intensity of the Australian electricity market. This will help mitigate the transitional risks posed by climate change.

## Global analysis applied at a local level

Considering climate risks are geographically dependent, thorough asset and city specific analysis is required to adequately identify the climate risks, especially the physical risks, presented.

Whilst the analysis conducted by the UNEP FI team is a wonderful start, the challenges posed by considering multiple asset classes across tens of countries and hundreds of cities poses a unique challenge.

Given the breadth of the task, not all physical climate risks could be assessed in the proper detail. With those risks that were assessed, lacking the depth of analysis required to properly project and value risk.

For example, the risks posed by fluvial flooding and heaving precipitation were not considered in the real estate model due to the complexity of modelling fluvial flooding. Whilst there are plans to integrate such physical risk into future analysis, it renders the existing analysis incomplete. This is particularly concerning given the prevalence of flooding in Brisbane, where six of Investa's assets were assessed.

Another example considers heat risk. The analysis returned limited risk posed by heat waves with some assets returning a positive impact when assessed (meaning extreme heat peaks were decreasing for those assets in question). This is in conflict with lived experience in Australian cities, with 2018 being the third hottest year on record according to the Federal Bureau of Meteorology. It is difficult to reconcile Carbon Delta's risk assessment against present trends, with Investa's assets subjected to increasingly hotter and longer summers.

Consequentially, we will conduct further analysis at an individual asset/city level to consider the full extent of risks not able to be covered by the present assessment, chiefly heat and fluvial flooding.

## Conclusion

The initial results of the UNEPFI's Real Estate Working Group's analysis showcases the strength of Investa's portfolio to respond to the transitional risks posed by 3°, 2° and 1.5° climate scenarios. Whilst the 1.5° scenario requires the steepest reduction in emissions, Investa's ambitious carbon reduction target and existing track record of reducing emissions, will allow the portfolio to mitigate the risks identified.

Assets' location was an identified variable impacting the climate resilience, with Investa to consider geography when assessing assets against the physical and transitional risks identified in this analysis.

Lastly, whilst the analysis conducted to date represents a starting point, Investa is committed to enhancing the analysis of physical risks (specifically fluvial flooding and heat waves) and expanding transitional risks to include scope 3 emissions moving forward.

# ANALYZING CLIMATE RISK: A STRATEGIC GLOBAL PRIORITY FOR LASALLE INVESTMENT MANAGEMENT

**Summary:** LaSalle has found the UNEP-FI TCFD Pilot insightful and educational as the firm develops its house strategy to incorporating climate risk into all investment decisions.

## Framing Climate Change in LaSalle's Investment Strategy

In 2017, LaSalle added Environmental Factors ("E-Factors") to its house investment strategy to form "DTU+E" given E-Factors close link to the other secular, long-term drivers of real estate demand: Demographics, Technology, and Urbanization. E-Factors include: energy conservation, carbon footprint reduction, climate change, water reduction and waste recycling, and green building certifications/ratings. We did this based on our house view that the pricing of E-Factors and the return on investment (ROI) for improving the environmental performance of an asset will increase over time, taking local market conditions into account. We also introduced economic and financial frameworks for analyzing the risk-return characteristics of E-Factors. These analytical tools ensure that sustainability features are appropriately priced in a disciplined way to improve both financial and environmental performance.


**Figure 30:** DTU+E Investment Strategy map

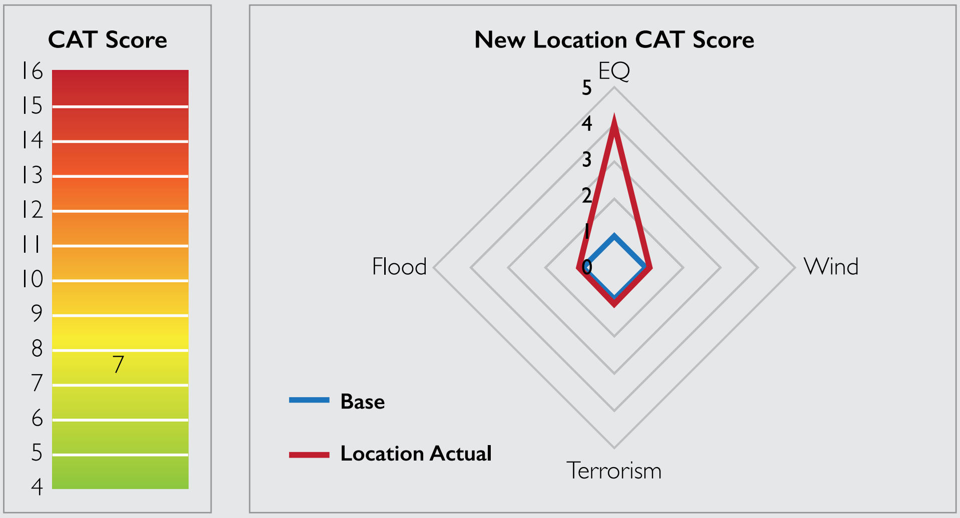
In framing ESG in LaSalle's DTU+E investment strategy, we include broader concepts like resilience (which focuses on adaptation strategies for climate change, in contrast to mitigation strategies for greenhouse gas emissions), social sustainability (which focuses on economic/ social justice issues), and health/welfare (which focuses on the well-being and safety of individuals who build, occupy and travel to buildings). Today, it is clear that the definition of "sustainability" has expanded to include the inevitable consequences of climate change. Our approach acknowledges that no sustainability initiative can quickly reverse decades of ever-higher levels of carbon dioxide and other greenhouse gases put into the atmosphere. The broader approach also acknowledges that human factors—how people interact with buildings—also deserves attention. In other words, real estate investors have a role to play in how buildings contribute to a healthy and just society, as well as in better stewardship of natural resources like air and water. Finally, the concept of "resilience" suggests that it will be prudent for property investors to anticipate that severe weather (windstorm, flood, extreme heat/cold, wildfire, droughts, other) will occur regardless of humankind's success or failure at reigning in its impact on the natural environment, and should be considered at multiple levels—from the building to the market to the country/region—for potential to impact business operations and consequently long-term performance.

By adding "E" to the DTU framework, we committed to continue to conduct and review rigorous research in order to refine our approach to incorporating climate change in our investment process. Furthermore, we recognize there is interplay between the four components of DTU+E and climate change has implications on these intersecting secular trends beyond what each one may have in isolation. This is why we participated in the UNEP-FI pilot and continue to refine LaSalle's house approach. LaSalle's Global Sustainability & Risk Management teams participated together in the pilot project in order to advance our understanding on the implications of climate change on real estate, and further, to better understand the physical, transition and liability risks in order to ultimately have the ability to assess these risks across LaSalle's entire portfolio.

## Our Efforts on Climate Change to Date

Climate change is a broad term encompassing myriad different risks. As defined in this report, most of the narrative on the subject segments climate change into two risk categories: physical risks and transitional risks. The first addresses the direct impact to assets from extreme weather events, sea level rise and changing weather patterns. The second category involves broader societal, economic and political implications. The company has insurance coverage focused primarily on the direct physical risks for its insured assets. Considerable effort is spent assuring the insurance coverages are well matched with the company's asset portfolio and reflect best available insurance market terms and conditions.

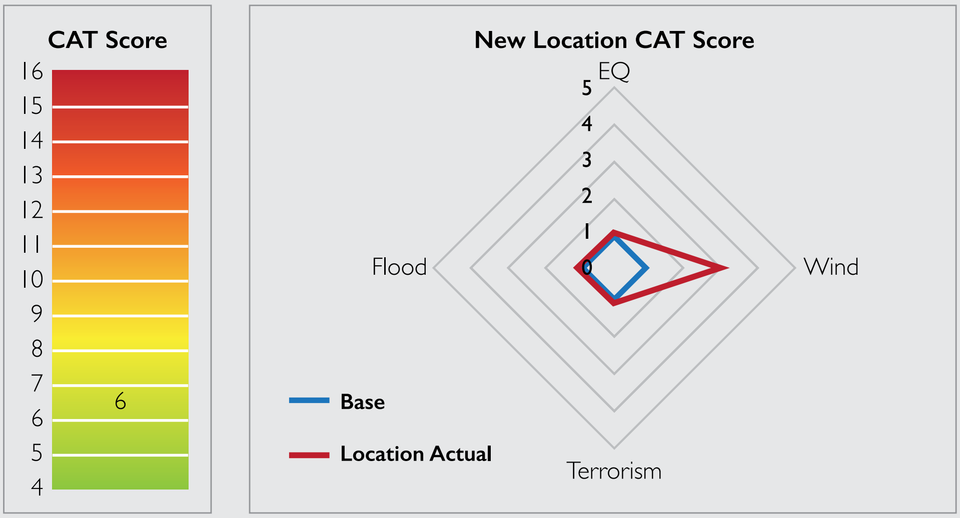
Regional approaches have been developed internally with particular focus on coverage for natural catastrophes - earthquake, flood, windstorm, etc. - and includes modeling for these perils. For example, every U.S. asset acquisition receives a 'Cat Score' based on its location and risk attributes applicable to four catastrophe categories: earthquake, flood, wind and terrorism. The 'Cat Score' is a proprietary, numeric score developed by LaSalle and its risk management advisor, Aon. The score affords comparison to other acquisitions and pending transactions and identifies which of the four catastrophe categories are the major contributors to the asset's total score. The 'Cat Score' also provides a portfolio level view of these risks. Supplementing the score is further quantitative analysis focusing on the insurance costs that coincide with the 'Cat Score'. Every asset has a base insurance cost, reflecting the cost to insure absent any surcharges for catastrophe exposures. A total insurance cost is then calculated to reflect additional insurance charges coinciding with the asset's catastrophe exposure. The additional cost can then be reflected in pro forma expense projections and stress tested for scenarios where insurance catastrophe premiums may have more volatility than other expense projections.




***Base** - Low Hazard Flood Zone, No EQ Surcharge, No Wind Surcharge, Low Terrorism Risk
***Flood Zone** - Check FZ in Impact On Demand Tool

| Base Premium | CAT Adjusted Premium | Difference |
|---|---|---|
| US$120,301 | US$473,310 | US$353,009 |

**Figure 31:** California Earthquake Exposure




***Base** - Low Hazard Flood Zone, No EQ Surcharge, No Wind Surcharge, Low Terrorism Risk
***Flood Zone** - Check FZ in Impact On Demand Tool

| Base Premium | CAT Adjusted Premium | Difference |
|---|---|---|
| US$10,050 | US$12,358 | US$2,308 |

**Figure 32:** Wind Exposure

## Limitations & Lessons Learned from the Pilot

LaSalle's 'Cat Score' and current regional approaches are derived from the underwriting and modeling analysis used by LaSalle's insurers to price premiums for natural catastrophe coverages. This analysis is inherently backwards facing and a significant limitation. A limitation of the climate risk modelling approach developed in the pilot is that it is based solely on geo-location and asset value, without taking into consideration initiatives already implemented or planned at each asset. As such, the singular Value at Risk (VaR) metrics for each climate-related risk (i.e. extreme heat) and as an aggregate for physical and transition risk are too specific for LaSalle's typical approach to risk. Rather, we are seeking to develop lower and upper bound VaR metrics as risk tolerance bands in which we can consider initiatives already implemented or planned at each asset. With the outputs available from our current regional risk analysis, Carbon Delta's analysis outputs from this pilot, and additional climate risk analysis that LaSalle is planning on conducting, we will begin to reconcile these outputs and supplement the insurance models to develop LaSalle's risk tolerances for inclusion in our investment decision-making.

## Looking Beyond the Pilot

LaSalle has recognized that we must increase our efforts now in order transition to a low carbon economy to stave off the most severe impacts from climate change. This is why LaSalle's UK business has signed on to the UK Better Buildings Partnership Climate Change Commitment, which highlights the need for buildings to be net zero carbon by 2050, for both embodied and operational carbon, and commits LaSalle as a signatory to publicly publish our own pathway to achieving this by the end of 2020. With this commitment, we recognize that the pathways developed at the asset and fund levels may have considerable cost, but also believe aligning our assets with a 1.5-degree scenario affords significant opportunity. While LaSalle plans to further explore the implications of climate-related transition risks and opportunities, the Carbon Delta analysis from this pilot has provided a good starting point to understanding the protection of asset value that we can affect through our commitment to net zero carbon by 2050.

Further, LaSalle's aim is to incorporate climate risk in all investment activities in order to not only protect, but also enhance the value of our clients' investments. For many years, LaSalle had a Climate Change Committee that focused on these efforts in a qualitative manner. In 2016, we merged that committee with our broader firm-level ESG initiatives with a focus on ESG implementation to mitigate the impacts of climate change. Our 'Value at Risk' pilot with Carbon Delta has been an important impetus in enhancing LaSalle's climate change risk assessment from a qualitative narrative to incorporating a more quantitative financial impact. Building on this analysis a key focus as the company moves to TCFD disclosures and its emphasis on "transparency in pricing risk". As a result of our participation in the pilot, LaSalle is re-launching our climate change initiative as our Climate Risk Committee in order to refine LaSalle's position regarding climate change, provide our fund managers with guidelines related to climate risk for our decision-making processes, and further educate all employees, in particular research & strategy, acquisitions, fund management, and asset management on the effects of climate change on the real estate industry.

An intended outcome from our Climate Risk Committee is to disclose climate risks within a TCFD aligned report, both at the enterprise/firm level and for each LaSalle fund/account. This work will be used as a tool to communicate to clients and stakeholders how LaSalle integrates climate risks and opportunities into investment decision-making processes across all asset classes and which climate-related factors LaSalle may consider when making such decisions, while remaining focused on maximizing investment performance and LaSalle's fiduciary obligations to its clients.

# CLIMATE VALUE-AT-RISK PORTFOLIO ANALYSIS – INSIGHT INTO FORTHCOMING ASSET MANAGEMENT

## LINK AND CLIMATE RISK

Link Real Estate Investment Trust (Link) is Asia's largest REIT and one of the world's largest REITs (with focus on retail) in terms of market capitalization. With a diversified portfolio, we aim to deliver sustainable growth and create long-term value for Unitholders and other stakeholders. Committed to delivering on our vision to be a world class real estate investor and manager, serving and improving the lives of those around us, Link unveiled Vision 2025, outlining medium-term goals in three focus areas: portfolio growth, culture of excellence and visionary creativity.

Link plays a leading role in the UNEP FI's effort to develop ground-breaking and comprehensive guidance on how to assess the impact of climate change on investment portfolios and in particular, real estate-focused portfolios. Previously, Link relied on a set of primarily qualitative indicators to quantify the portfolio's overall climate risk. However, a lack of quantitative transparency and accountability on specific assets at risk presented difficulties in developing and prioritizing both portfolio and asset-level climate mitigation strategies. Through this pilot initiative, Link gains a better understanding of the short, medium and long-term climate-related risks our current portfolio is exposed to, including extreme weather events such as flooding, tropical cyclones and instances of very hot and cold days.

As one of the few real estate participants in Asia, we strive to catalyse climate adaptation and sustainable development in the region. As a participant of the UNEP FI TCFD pilot program, we identified our preliminary material risks and associated exposure to potential financial impact. This enables us to have direct dialogue with investors around the resiliency of real estate assets, the associated financial exposures and the potential return from investing in mitigation strategies. More importantly, since the development of this methodology encompassed input from both investors and real estate businesses, the chosen indicators and data points are well understood and meaningful to both parties.

## OVERVIEW OF CVAR PORTFOLIO ANALYSIS

The CVaR portfolio analysis estimates the aggregated and current financial risks an asset portfolio may face in light of various transition and physical scenarios. Using the REMIND model, a 2°C scenario was assumed as the primary policy criteria to assess Link's transition risk. The physical scenario consisted of extreme heat, coastal flooding and tropical cyclones, all of which induce both acute and chronic impact on Link's asset operations and management approach. As listed in Table 5, the aggregated CVaR is -0.18%, corresponding to an approximate discounted cost of US$55.67m. In aggregate, these results suggest that Link faces minimal transition and physical risk. It also provides valuable insight to support decision-making, including appetite for climate risk exposure, as well as the portfolio's sensitivity and adaptive capacity to long-term climate change scenarios.

Link's transition risk (-0.15%) is comparatively higher than physical risk (-0.04%)—amounting to a difference of US$32.89m discounted cost. These results are expected and can be explained by the fact that 80% of our assets are located in Hong Kong, where its topography and geographic location have shown to be resilient against extreme weather events in terms of both frequency and intensity. Transition risk—considering impact from policy change—presents a much larger challenge and can be considered as an "imminent" issue that needs to be addressed. It should be noted that the Hong Kong Special Administrative Region has yet to formally announce climate change commitments that adhere to international best practices. We expect Link's transition risk to increase once regulations and hard targets are put in place.

| Scenario | Weighted CVaR (%) | Discounted Cost (million USD) |
|---|---|---|
| **Transition Scenario (REMIND Model)** | **-0.15** | **-44.28** |
| Policy Risk (2°C) | -0.15 | -44.28 |
| **Physical Scenario (Average Model)** | **-0.04** | **-11.39** |
| Extreme Cold | +0.00 | 0.00 |
| Extreme Heat | -0.00 | -0.04 |
| Extreme Wind | +0.00 | 0.00 |
| Coastal Flooding | -0.01 | -1.54 |
| Tropical Cyclones | -0.03 | -9.81 |
| **Aggregated CVaR** | **-0.18*** | **-55.67** |

**Table 5:** Link's CVaR Portfolio Analysis – Overall Results. Source: Link & Carbon Delta

* Sum of aggregated CVaR is different due to rounding

## TOP 5 CVAR RISK CONTRIBUTORS AT THE ASSET LEVEL

The model has provided useful insight for us to understand the individual asset-level climate risk contributors. This allows a quantitative approach to be deployed when determining the priority of properties for implementation of climate mitigation strategies. Each risk contribution (Table 6) is determined by two major factors – asset weight and its aggregated CVaR. The results show that Link's top three risk contributors are assets located in Mainland China. Having this quantitative assessment and data on hand provides a good starting point to investigate where and how to start mitigating climate risk.

Upon further investigation, Asset 1 in Mainland China has the highest risk level overall primarily due to geographic exposure to specific physical hazards, in this particular case, coastal flooding and tropical cyclones. Assets 2 through 5, have similarly valued CVaR risk contributions of -0.01%. A rather interesting observation is the fact that over 90% of our properties have an estimated CVaR of 0%, indicating negligible impact from both transition and physical risks. This somewhat surprising result can be attributed to the following three reasons:

1. Hong Kong generally has a high level of resilience towards extreme weather occurrences;
2. The majority of our assets are in Hong Kong, leading to similar risk profiles; and
3. Property values in Hong Kong are among the highest in the world, thus the potential transition and physical mitigation costs often pale in comparison to the property value.

| # | Region | Weight (%) | Sector | Transition Risk CVaR (%) | Physical Risk CVaR (%) | Aggregated CVaR (%) | Risk Contribution (%) |
|---|---|---|---|---|---|---|---|
| 1 | China | 2.33 | Retail | -0.42 | -0.26 | -0.69 | -0.02 |
| 2 | China | 3.72 | Office | -0.33 | -0.01 | -0.33 | -0.01 |
| 3 | China | 1.47 | Retail | -0.56 | -0.00 | -0.56 | -0.01 |
| 4 | Hong Kong | 1.25 | Retail | -0.55 | -0.04 | -0.59 | -0.01 |
| 5 | Hong Kong | 0.88 | Retail | -0.57 | -0.04 | -0.61 | -0.01 |

**Table 6:** Top 5 CVaR Risk Contributors at Asset Level. Source: Link & Carbon Delta

## Downside transition costs under 1.5°C, 2°C and 3°C scenarios at the portfolio level

Table 7 presents the breakdown of unweighted CVaR transition risk posed to Link's portfolio at 1.5°C, 2°C and 3°C scenarios. Expectedly, when climate policies become more stringent, the associated transition costs will rise. The insight, however, comes from being able to estimate the rate at which costs will increase according to different climate scenarios. The relationship is not necessarily linear and can provide valuable insight for businesses to strategically budget and plan for mitigation strategies. In Link's case, a change from a 3°C to 2°C scenario has a 15-fold increase in terms of transition risk and downside costs, while pursuing an additional 0.5°C decrease to a 1.5°C scenario, has a 43-fold increase in costs (Table 3).

| Scenario (°C) | Unweighted Total Portfolio CVaR From Transition Risk (%) | Total Downside Transition Costs (million USD) |
|---|---|---|
| 3 | -0.45 | -1.88 |
| 2 | -6.95 | -28.27 |
| 1.5 | -22.73 | -81.64 |

**Table 7:** Unweighted total portfolio CVaR and downside transition cost (discounted) for 1.5°C, 2°C and 3°C scenarios. Source: Link

## Conclusion and suggestions

It is clear from the data that there are significant differences in physical and transition risks even between cities that are situated close to each other. For example, the model predicts that increasing frequency and severity of heavy rainfall will pose the greatest physical risk to our Hong Kong properties, while coastal flooding will be the predominant physical hazard – by far – for properties located in adjacent cities, despite all being in the Pearl River Delta. This highlights the importance of having individual and city-level climate mitigation strategies in place.

The model has also been useful in assessing future investment opportunities by providing a glimpse of what the long-term climate-related challenges in specific areas may be. For example, if the model suggests a particular asset as having high risk of flooding, the investment due diligence process may expand to include assessing the resilience of local utilities and services, investigating urban development plans of the city and even give some foresight into what future mitigation or adaptation measures need to be considered. These can be factored into the decision-making process for potential investments.

## Reflections of the pilot program and moving forward

Whether in response to observed or anticipated impacts on operations, or due to increasingly stringent policies and regulations, the urgency for businesses to address climate change has accelerated. The physical impacts of climate change on the real estate sector are well documented. More pressing however, are the subsequent social issues – food and water security, human health, and vulnerability – that will undoubtedly arise, all of which the real estate sector plays a critical role to help mitigate.

Locally in Hong Kong, we have seen the number of extreme heat days increase, but more concerning, is that average daily temperature has also increased. Instead of having to manage isolated instances of extreme events as in the case of extreme heat, an increase in average daily temperature represents a new normal, which requires businesses to evaluate, update and perhaps overhaul daily operations. Using the UNEP FI TCFD tool is an important first step to develop a quantifiable understanding of the climate-related risks and opportunities that Link faces.

In addition, the pilot program also provides an initial step in offering an aligned, comprehensive and comparable framework for investors to identify an asset's implicit climate cost and opportunities. This brings more information to investors compared to the usual ESG ratings and industry benchmarks. The CVaR metric also enhances flexibility for users to gain insight into different climate scenarios to accommodate differing risk appetites and investment strategies.

To reiterate, the model is a good initial step to provide quantitative data for investors and asset owners to utilize. The true strength of the model will be realized once it is populated with local-specific GIS data, including elevation, land improvements, adjacent structures and details on policy initiatives.

Moving forward, Link will continue to align ourselves with the TCFD recommendations in our annual integrated report and fine tune disclosures of climate-related financial information. We believe ongoing engagement on climate resilience is crucial. This includes continuing collaborations with our investors and engaging more closely with city-level and regional-level policymakers to develop comprehensive climate resilience strategies.

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