Responsible Asset Allocator Initiative (RAAI)

at the Fletcher School

11th RAAI Roundtable

KEY TAKEAWAYS

The economic case for investing in climate change

Research by the Responsible Financial Benchmarking Lab (RFBL)*

Scott Kalb, Director, RAAI
Delilah Rothenberg, Director, PDI

Nov 21, 2025, 2:00 – 5:00 pm
Four Seasons Hotel, Singapore

* The RFBL was renamed the Responsible Climate Asset Allocators Lab (RCAL) in Feb 2026

Agenda

In this interactive Roundtable, delegates will share insights on how risks such as climate change, inequality, and nature loss, are or are not currently being incorporated into capital market assumptions, benchmarking practices, and investment strategies, to build resilient portfolios.

To date, we have hosted ten roundtables with asset allocators and other stakeholders to form a baseline assessment of strategies used to face long-term systematic risks, and identify gaps that exist in current approaches. During this RFBL Roundtable we will report on what we have learned thus far, reflect on the results, and consider next steps for advancing solutions. All sessions operate under Chatham House Rule.

Time	Topic Session
14:00 - 14:15	**Introductory remarks and stage setting** RFBL co-founder Scott Kalb, Director of the Responsible Asset Allocator Initiative (RAAI) will set the stage.
14:15 - 15:00	**Emerging approaches to systematic risks: Investing in Climate Adaptation, by GIC** DeRui Wong, Senior Vice President, Sustainability Office at GIC, will discuss the findings from his report Sizing the Inevitable Investment Opportunity: Climate Adaptation. DeRui will present a compelling case for building resilient portfolios by focusing on adaptation strategies in the face of systemic climate change risks.
15:00 - 15:45	**Making the Economic Case for Investing in Climate Change** If we hope to mobilize capital toward solutions for climate change and other systematic risks, we need to make a strong top-down economic case for doing so. Asset allocators need this case to justify altering their allocation models, especially in the US where they are under attack for "wokeism." Scott will present findings from a paper he co-wrote with Paul O'Brien, former Deputy CIO of ADIA, showing that by adjusting CMAs, asset allocators can make a compelling economic case for investing in climate change solutions.
15:45 - 16:30	**Special Presentation - AI for Asset Allocators: A New Framework?** Kristian Flyvholm, CEO and Chairman of the Institute of Sovereign Investors, former CEO of the IFSWF, and CIO of various institutions, will discuss key themes from the recent ISI paper AI for Sovereign Wealth Funds - Integration into Investment Frameworks. Kristian will present a compelling case for asset allocators to use AI to build operational efficiency, add alpha, and manage risk.
16:30 - 17:00	**Closing Remarks and Reception**

Key Takeaways: Slide Presentations

We present below the three slide presentations provided by the speakers at the Roundtable, as noted in the agenda. Discussion focused on these presentations and Q&A with the speakers.

ATTENDEE LIST

Ms Elsa Allman
Head of Climate Change
Banque de France
Paris, France

Mr. Herve Thoumiand
Head of Trading Room
Banque de France
Singapore

Mr. Reza Mahmoud
Former PM, **Brunei Investment Agency**
Consultant, **Institute of Sovereign Investors**
Singapore

Ms. Shifat Hasan
Head of Performance and Compliance
CalSTRS
Sacramento CA, USA

Ms. Anita Goh (D)
Associate Director, SEA
Capital Group
Hong Kong

Mr. Kristian Flyvholm
Former CIO, **Central Bank of the UAE**
CEO, **Institute of Sovereign Investors**
Copenhagen, Denmark

Ms. Megan Ford
ED, Investment Capability and Intelligence
Future Fund
Melbourne, Australia

Mr. DeRui Wong
Senior VP, Sustainability Office
GIC
Singapore

** Co-founder, RFBL
(D) Dropped

Mr. Hisham Hamdan
Chief Investment Officer
Khazanah
Kuala Lumpur

Mr. Ahmad Bastaki
Former Executive Director
Kuwait Investment Authority
Kuwait City, Kuwait

Ms. Jenny Nguyen (D)
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Hong Kong

Mr. Jovy Ismail (D)
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Mr. Scott Kalb**
Founder and Director
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Chief of Division
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Ms. Delilah Rothenberg (V)**
Founder and Director
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Paul O'Brien (V)**
Former Deputy CIO, **ADIA**
Board Member, **Wyoming Retirement System**
Wilson, Wyoming

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Eleventh RAAI Roundtable – Singapore

Slide Presentations

- Making the Economic Case for Investing in Climate Change Solutions: It's Not About the Woke Stuff, *Scott Kalb*, **RAAI, RFBL, KIC**
- Climate Adaptation – The Inevitable Investment Opportunity, *DeRui Wong*, **GIC**
- AI for Sovereign Investors, Integration Into Investment Frameworks, *Kristian Flyvholm*, **Institute for Sovereign Investors (ISI)**

Nov 21, 2025

Four Seasons Hotel, Singapore

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Responsible Asset Allocator Initiative (RAAI)
Eleventh Roundtable

Making the Economic Case for Investing in Climate Change Solutions: It's Not About the Woke Stuff

*By Scott Kalb**
Director, Responsible Asset Allocator Initiative at the Fletcher School
Former Chief Investment Officer, Korea Investment Corporation

Nov 21, 2025
Four Seasons Hotel, Singapore

Note: this presentation is based on research undertaken by the RFBL and a chapter written by Scott Kalb and Paul O'Brien, "CMAs and System Level Investing" for the **Handbook on System Level Investing*

Responsible Financial Benchmarking Lab

Investors lack the ability to invest in system-wide solutions on their own

The RFBL is designed as a dedicated forum for asset allocators to learn from one another and develop:

- Solutions to overcome limitations to traditional benchmarking practices
- Approaches to consider externalities in capital market assumptions (CMAs)
- Tools to systematically risk-adjust returns beyond considering idiosyncratic factors
- A high-level understanding of tools to value and account for externalities at a corporate level

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Problem Statement

- To mobilize investment capital toward solutions for climate change, asset allocators need a top-down systematic approach that is risk and return focused. Sustainability advocates should support this case.
- Asset allocators have a legal requirement to be fiduciarily responsible. This necessarily tilts their focus towards financial performance over environmental and social impact.
- Allocators that embed sustainability in portfolios say risk & return benefits are essential to justify them. Few say that meeting sustainability objectives, in and of itself, is sufficient.
- Rather than apply pressure on allocators to alter governance structures or mission statements, focus on building a strong risk-and-return case to help them invest in solutions.

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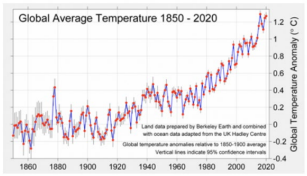
Proposition

- A powerful top-down systematic approach for asset allocators is to adjust the macroeconomic data in their capital market assumptions (CMAs) for climate change.



- CMAs provide 10-20-year risk and return expectations across asset classes and regions and are used by Asset Allocators to construct portfolios and build strategic asset allocation models.

- Current CMAs do not adjust for climate change. They are based on historic trends and valuations, but we are headed toward uncharted territory – 2.7 degrees above baseline – levels not seen for 3 mm years.

- Climate-adjusted CMAs can help asset allocators align portfolios with a realistic future and show how to minimize long-term risks while maximizing returns, even in a “hot-house” world scenario.

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Challenges in Adjusting CMAs for Climate Change

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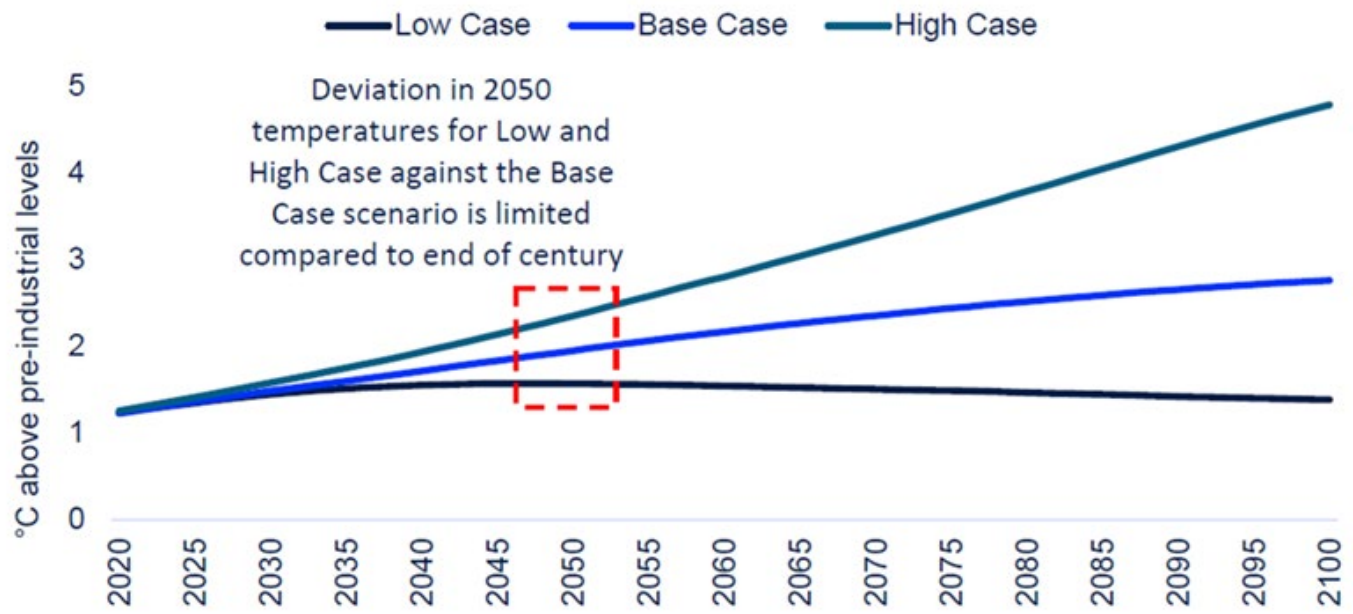
The pathway for temperature change is uncertain

Figure 4: Global warming pathways in climate change scenarios



Source: GIC Sustainability Office analysis, Bain & Company, IPCC

- **The direction and pace of travel for climate change is uncertain. Divergence doesn't happen for another ten years.**
- **This makes it difficult to justify climate investments in the short-term or consider the cascading impact of "tipping points."**
- **But as global warming continues and climate-related weather events increase in frequency and intensity, allocators must reshape portfolios for the future.**

Source: Sizing the Inevitable Investment Opportunity: Climate Adaptation, GIC, Bain

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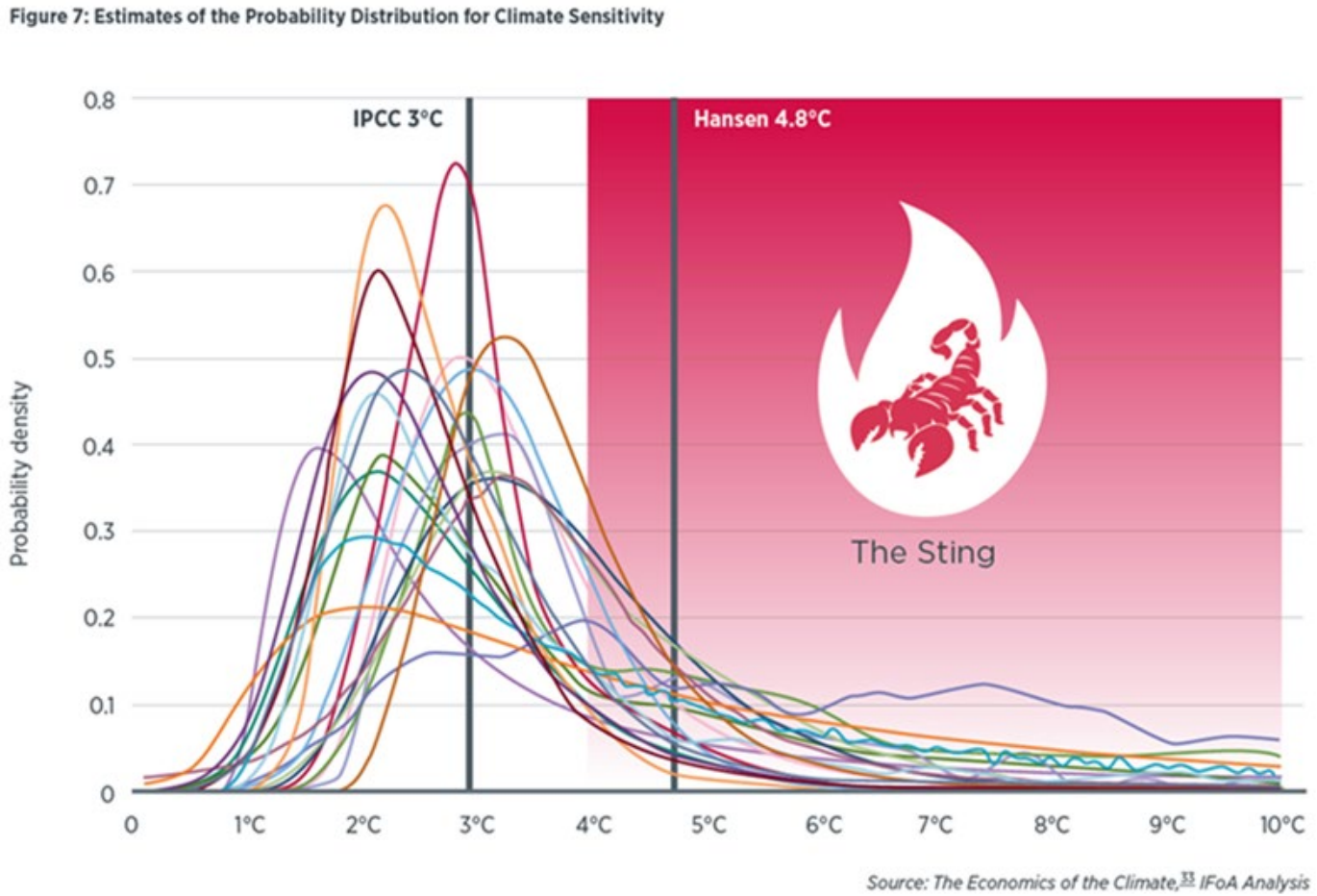
Global warming scenarios have “fat tails.”



Source: Climate Scorpion: the Sting is in the Tail, Institute and Faculty of Actuaries (IFOA)

Risks that are low probability but highly significant in impact are called “fat-tail” risks. They can be seen outside the bell curve of probable temperature scenarios extending to the right. These events should be discounted in forward-looking risk and return models.

Global warming scenarios have very fat tails. The risk of global warming reaching 3.0-4.0 degrees above baseline, a “hot house world” scenario according to the NGFS, has risen to 30%. The risk of reaching 4.8%degrees above baseline, a disaster scenario, is now about 18%

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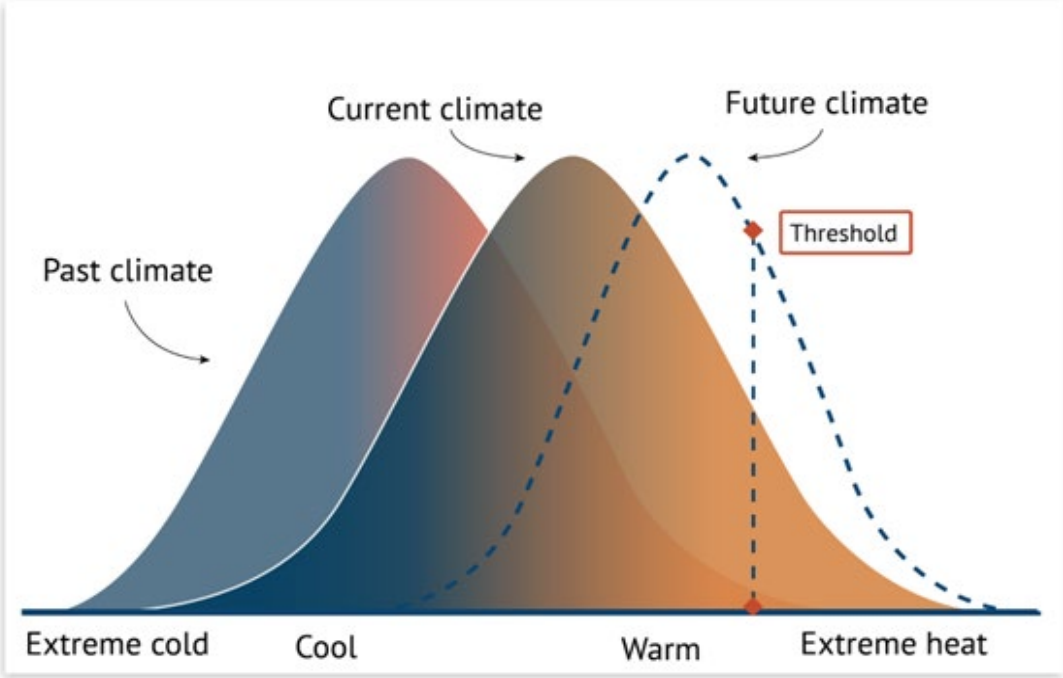
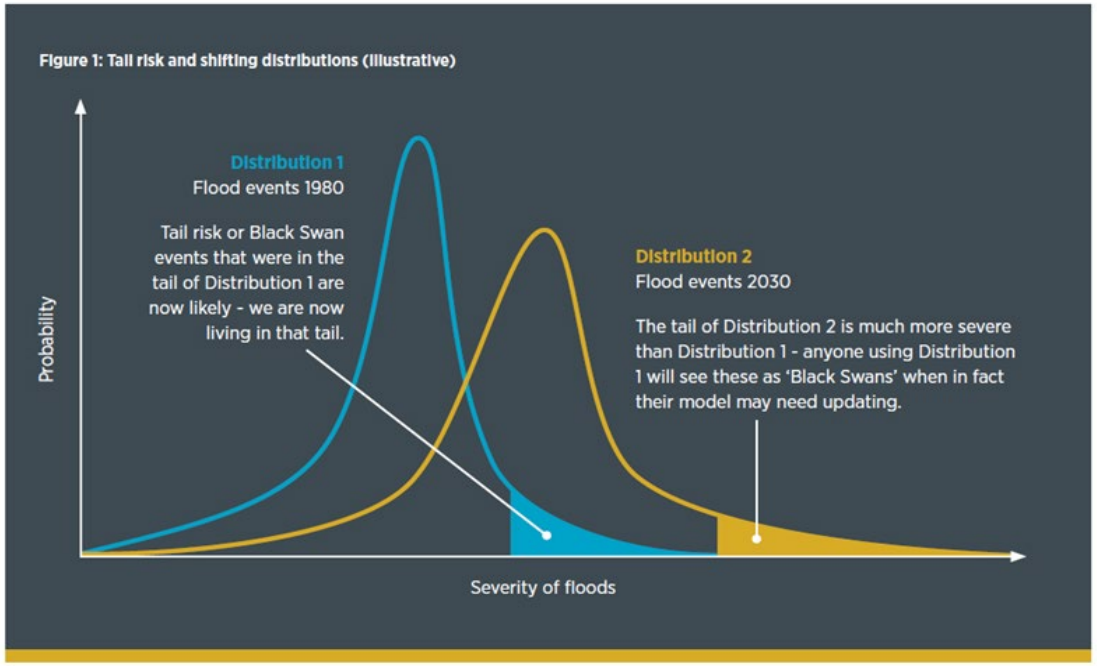
The Bell curve of probable climate events is shifting

The probability of severe weather events grows faster than for less extreme events as temperatures rise and the distribution of probable outcomes (bell curve) shifts to the right.



Tandon, Ayesha. *Q&A: The Evolving Science of "Extreme Weather Attribution*," Nov 18, 2024, Carbon Brief

Yesterday's fat tails are today's high probability events. Today's fat tails are yesterday's black swans. The impacts may be uncertain, but we must plan for extreme climate risks in portfolios.



Source: Climate Scorpion: the Sting is in the Tail, Institute and Faculty of Actuaries (IFOA)

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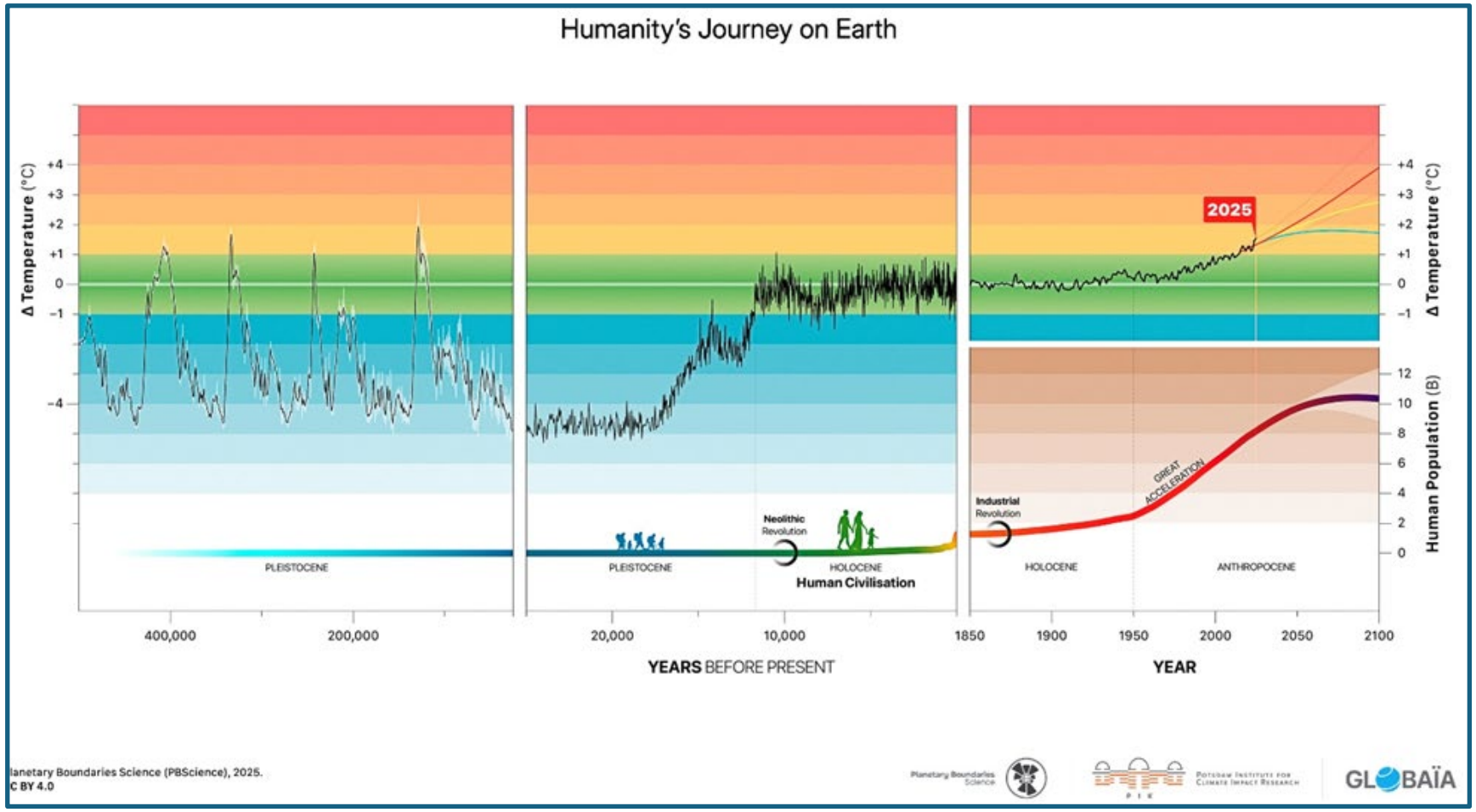
We are in uncharted territory, with little historical context



We have not breached two degrees above baseline for three million years. We are heading toward uncharted territory.

The lack of historical context and data makes it especially hard to model outcomes.

Planetary Boundaries Science (PBScience). 2025. Planetary Health Check 2025. Page 37. Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany.

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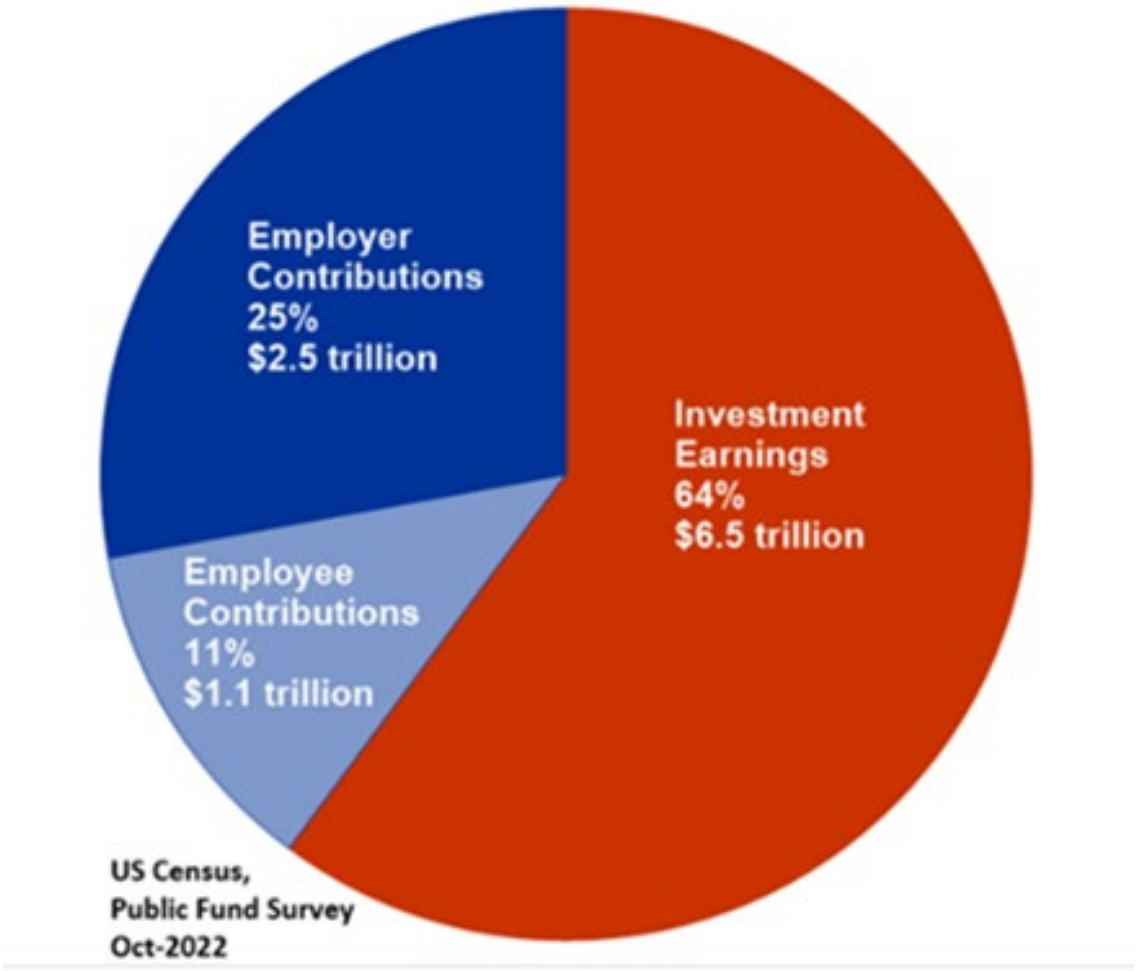
Over 60% of pension payouts come from investment returns



- If returns for pension funds are lower than forecast in actuarial CMAs, pensions will face shortfall risk – the risk of not being able to meet payout obligations.
- Lower than expected returns reduce funding ratios and necessarily require greater contributions from employers and employees to keep pensions solvent.

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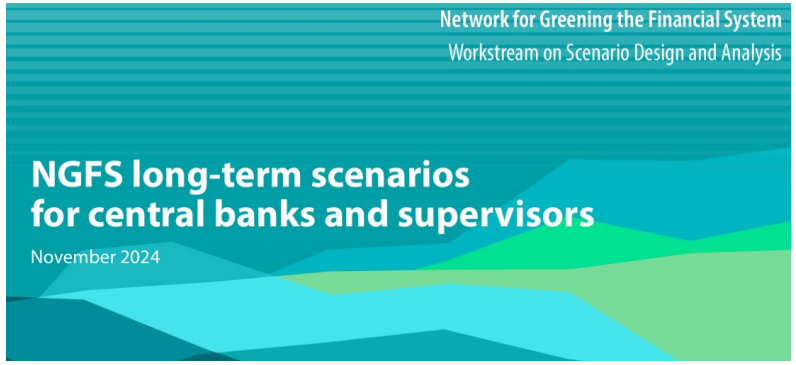
Adjusting CMAs for Climate Change using tools from the Network for Greening the Financial System (NGFS)



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Comparing Baseline Economic Projections (used in CMAs) with Climate-adjusted forecasts

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USA economic outlook deteriorates under warming climate

United States - 20 year Climate Adjusted Projections					
Indicator	Baseline	Orderly 1.5°C	Disorderly 2.7°C	Hothouse 3.0–4.0°C	Sources
GDP Growth (%)	2.2	2.0	1.7	1.5	Horizon CMAs, IMF WEO
Inflation (%)	2.3	2.6	3.2	3.5	NGFS Phase V, Federal Reserve
Interest Rate (%)	3.2	3.5	4.1	4.4	NGFS overlays, Fed long-run neutral
Earnings Growth (%)	4.6	4.3	3.9	3.6	IMF WP/22/145, ND-GAIN, Aqueduct

Notes: Analysis by Scott Kalb, Director, RAAI at the Fletcher School

-Sectoral damage multipliers applied to earnings growth reflect exposure in energy, real estate, and manufacturing.

-High ND-GAIN score (~70), shows strong adaptive capacity, but regional disparities (Gulf Coast, Southwest) increase physical

-Aqueduct overlays highlight rising water stress and flood risk in key urban corridors (e.g., Miami, Houston, New York).

-Orderly scenario assumes early carbon pricing and green infrastructure investment; Disorderly reflects abrupt policy shifts and stranded assets; Hothouse models chronic physical disruption, migration, and productivity drag.

Table shows baseline 20-year macroeconomic projections compared with climate-adjusted projections under three NGFS scenarios - Orderly Transition (1.5 degrees), Disorderly Transition (2.7 degrees, current trajectory), and Hot House World (3-4 degrees).

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So do European economies

Europe (EU-27 + UK, Norway, Switzerland) -Climate Adjusted 20 yr Projections					
Indicator	Baseline	Orderly 1.5°C	Disorderly 2.7°C	Hothouse 3.0–4.0°C	Sources
GDP Growth (%)	1.8	1.6	1.3	1.0	Horizon, IMF WEO
Inflation (%)	2.0	2.4	2.9	3.3	NGFS, ECB macro overlay
Interest Rate (%)	2.8	3.1	3.6	3.9	NGFS, ECB
Earnings Growth (%)	4.0	3.6	3.1	2.7	IMF WP/22/145, ND-GAIN, Aqueduct

Notes: Analysis by Scott Kalb, Director, RAAI at the Fletcher School

-Sectoral drag from manufacturing, transport, and energy-intensive industries.

-Southern Europe faces rising water stress and heat exposure (Aqueduct Tier 3+).

-ND-GAIN scores reflect moderate vulnerability but strong adaptive capacity (Germany 70+, Spain 65+).

-Disorderly and Hothouse scenarios assume delayed carbon pricing and higher physical damage costs.

Table shows baseline 20-year macroeconomic projections compared with climate-adjusted projections under three NGFS scenarios - Orderly Transition (1.5 degrees), Disorderly Transition (2.7 degrees, current trajectory), and Hot House World (3-4 degrees).

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Emerging Markets economies hardest hit, no buffers

Southeast Asia (Indonesia, Malaysia, Thailand, Vietnam, Philippines, Singapore) - Adjusted 20 yr Projections					
Indicator	Baseline	Orderly 1.5°C	Disorderly 2.7°C	Hothouse 3.0–4.0°C	Sources
GDP Growth (%)	5.0	4.7	4.2	3.6	Horizon, IMF WEO
Inflation (%)	3.2	3.5	4.0	4.5	NGFS, ADB regional overlays
Interest Rate (%)	4.2	4.5	5.0	5.4	NGFS, ADB
Earnings Growth (%)	6.0	5.5	4.9	4.3	IMF WP/22/145, ND-GAIN, Aqueduct

Notes: Analysis by Scott kalb, Director, RAAI at the Fletcher School

-High exposure to coastal flooding, typhoons, and heat stress (Vietnam, Philippines flagged Tier 4+).

-Sectoral vulnerabilities in agriculture, infrastructure, and informal services.

-ND-GAIN scores indicate low adaptive capacity (Vietnam ~45, Philippines ~50).

-Hothouse scenario assumes chronic disruption to food systems and urban infrastructure.

Africa (Nigeria, South Africa, Kenya, Egypt, Morocco, Uganda) - 20 yr Climate Adjusted Projections					
Indicator	Baseline	Orderly 1.5°C	Disorderly 2.7°C	Hothouse 3.0–4.0°C	Sources
GDP Growth (%)	4.2	3.8	3.2	2.6	Horizon, IMF WEO
Inflation (%)	5.0	5.4	6.0	6.5	NGFS, World Bank macro overlays
Interest Rate (%)	6.0	6.3	6.8	7.2	NGFS, World Bank
Earnings Growth (%)	5.5	5.0	4.3	3.7	IMF WP/22/145, ND-GAIN, Aqueduct

Notes: Analysis by Scott Kalb, Director, RAAI at the Fletcher School

-Sectoral damage multipliers highest in agriculture, mining, and informal services.

-ND-GAIN scores among the lowest globally (Chad 24.9, Sudan 30.1), signaling extreme vulnerability.

-Aqueduct flags severe water stress in Sahel, Nile Basin, and coastal West Africa.

-Hothouse scenario assumes widespread displacement, food insecurity, and infrastructure degradation.

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Climate-adjusted CMAs impact outlook for asset classes

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Current benchmarks do not reflect climate impacts

Typical Allocator Portfolio: Benchmark-Level Performance (20 Year Horizon)							
Description	Benchmark(s)	Return Est Horizon CMA	Vol. Est. Horizon CMA	Return @ 1.5°C	Return @ 2.7°C	Return @ 3.0–4.0°C	Volatility Range
Global Equities	MSCI All Country World Index (ACWI)	6.50%	13.00%	5.10%	4.20%	2.80%	13.5% – 16.0%
Global Fixed Income	Bloomberg Barclays Global Aggregate Bond Index	3.80%	6.00%	3.60%	3.30%	3.00%	6.2% – 7.0%
Private Equity	Cambridge Associates Global PE Index	9.20%	14.50%	8.50%	7.80%	6.90%	14.5% – 17.0%
Private Credit	Cliffwater Direct Lending Index (CDLI)	7.50%	8.00%	7.20%	6.50%	6.00%	8.2% – 9.5%
Infrastructure	EDHECinfra Broad Market Index	6.00%	10.50%	5.50%	4.80%	4.00%	10.8% – 13.0%
Real Estate	NCREIF Property Index (NPI)	5.50%	9.50%	5.20%	4.60%	4.00%	9.8% – 11.5%

Analysis: Scott Kalb, Director, RAAI at the Fletcher School

Equities and infrastructure are most sensitive to physical and transition risks under warming scenarios.

Private equity and credit show moderate degradation, with PE more exposed to macro and exit risk.

Fixed income and real estate offer relative stability but face inflation and valuation pressure under disorderly transitions.

Use this table to model asset-class-level stress tests, funded status erosion, or contribution elasticity under NGFS overlays.

When adjusted for NGFS climate scenarios (Orderly Transition, Disorderly Transition and Hothouse World) legacy benchmark returns are lower, and risks are higher than currently expected.

Without climate adjusted CMAs, allocators may construct portfolios that are overly exposed to risk and damage and underexposed to opportunities available from decarbonization and resilience.

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Climate resilient benchmarks show better long-term performance

Climate Resilient Portfolio: Benchmark-Level Performance (20 Year Horizon)							
Description	Benchmark(s)	Return Est Horizon CMA	Vol. Est. Horizon CMA	Return @ 1.5°C	Return @ 2.7°C	Return @ 3.0–4.0°C	Volatility Range
Climate Transition Equity	MSCI ACWI Climate Transition Benchmark (CTB)	6.50%	12.00%	6.30%	5.80%	5.20%	12.2% – 13.5%
Adaptation & Resilience Equity	Composite: MSCI Climate Action, S&P Global Water, FTSE Environmental Opportunities (Adaptation subset)	6.90%	11.50%	7.00%	6.60%	6.10%	11.5% – 12.8%
SDG-Aligned Fixed Income	World Bank Green Bond Index, JPMorgan ESG EMBI Index	4.20%	6.50%	4.30%	4.10%	3.90%	6.5% – 7.2%
Clean Tech & Impact PE	Cambridge Associates Clean Tech & Impact PE Benchmarks	9.50%	15.00%	9.80%	9.20%	8.50%	15.0% – 17.5%
ESG Infrastructure & Real Estate	FTSE Environmental Markets Index, GRESB Infrastructure Benchmark	6.00%	10.80%	6.20%	5.90%	5.50%	10.8% – 12.5%

Analysis: Scott Kalb, Director, RAAI at the Fletcher School

Adaptation & Resilience Equity and SDG-Aligned Fixed Income offer the most stable volatility profiles across warming scenarios.

Clean Tech & Impact PE delivers strong alpha but requires long-duration tolerance for elevated volatility.

ESG Infra & Real Estate buffers physical risk shocks and provides inflation-linked income — critical under 2.7°C and 3.0–4.0°C pathways.

CTB Equity captures transition upside but faces moderate volatility expansion under disorderly pathways.

CMAs can also be used by allocators to guide portfolio construction that improves returns and reduces risks. When adjusted for NGFS climate scenarios (Orderly Transition, Disorderly Transition and Hothouse World) climate resilient benchmark returns are higher, and risks lower, than for legacy benchmarks.

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Climate-adjusted CMAs show risks and opportunities

Current CMAs for typical (legacy) portfolios underestimate climate impacts. When climate adjusted, CMAs indicate lower than expected returns and higher risk.

By optimizing CMAs for climate resilience, asset allocators can construct portfolios with higher returns and lower risk, even under a hot house world scenario, encouraging investment in climate solutions.

Portfolio-Level Forecasts: Return & Volatility (10–20 Year Horizon)						
Portfolio	(Horizon CMA)		(NGFS Climate Scenarios)			
	Base Return	Base Vol	1.5°C CMA	2.7°C CMA	3-4°C CMA	Volatility Range
Typical Portfolio	6.50%	11.50%	5.10%	4.20%	2.80%	12.2% – 15.0%
Optimized Climate Resilient Portfolio	6.20%	11.00%	6.00%	5.60%	5.10%	10.5% – 12.2%

Analysis: Scott Kalb, Director, RAAI at the Fletcher School

Typical Portfolio Benchmark Weightings: 50% Global Equities (MSCI ACWI), 30% Global Fixed Income (Bloomberg Barclays Global Aggregate), 10% Private Equity & Private Credit (Cambridge Associates Global PE Index and Cliffwater Direct Lending Index (CDLI), 10% Infrastructure & Real Estate (EDHEC infrastructure Broad Market Index and NCREIF Property Index (NPI))

Optimized Climate Resilient Benchmark: 35% Climate Transition Equity (MSCI ACWI CTB), 15% Adaptation & Resilience Equity (Composite: MSCI Climate Action, S&P Global Water, FTSE Environmental Opportunities (Adaptation subset), 25% SDG-Aligned Fixed Income (Composite: World Bank Green Bond Index, JPMorgan ESG EMBI Index), 15% Clean Tech & Impact PE (Benchmark: Cambridge Associates Clean Tech & Impact PE), 10% ESG Infrastructure & Real Estate (Composite: FTSE Environmental Markets Index, GRESB Infrastructure Benchmark).

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Methodology, Key Differences, Conclusions

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Sources and Methodology

Climate-Adjusted CMAs (2025–2045) Methodology Summary	
Component	**Description**
Baseline Source	Horizon Actuarial 2025 Survey, IMF World Economic Outlook
Climate Adjustment Source	NGFS Phase V Explorer, IMF Climate Stress Testing Framework
Sectoral Damage Multipliers	IMF Working Paper WP/22/145 (firm level productivity studies, agriculture, energy, infra)
Physical Risk Indices	ND-GAIN Country Index (vulnerability, readiness), WRI Aqueduct 4.0 (water stress, flooding)
Aggregation Logic	Country-level weighted averages by region
Analysis: Scott Kalb, Director, RAAI at the Fletcher School	

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Key differences - unadjusted and climate adjusted CMAs

Dimension	Unadjusted Benchmark CMA	1.5°C (Orderly Transition)	2.7°C (Disorderly Transition)	3–4°C (Hot House World)
Return Drivers	Historical averages + valuation-based forecasts	Adjusted for green innovation and sector rotation	Adjusted for abrupt policy shocks and stranded assets	Adjusted for severe physical risk and sovereign stress
GDP & Inflation Inputs	Consensus macro forecasts	NGFS orderly overlays with stable inflation	NGFS overlays with inflation volatility	NGFS overlays with stagflation and supply chain shocks
Sector Weighting	Market-cap weighted	Tilted toward low-carbon sectors	Penalizes carbon-intensive sectors	Penalizes climate-vulnerable sectors (infra, agri)
Earnings Growth	Historical trend extrapolation	Boosted by green capex and policy certainty	Lowered due to transition disruption	Lowered due to physical damage and migration pressure
Fixed Income Yields	Yield curve extrapolation	Stable rates with moderate credit spreads	Elevated spreads and downgrade risk	Sovereign fragility and inflation-linked repricing

Dimension	Unadjusted Benchmark CMA	1.5°C (Orderly Transition)	2.7°C (Disorderly Transition)	3–4°C (Hot House World)
Private Equity Dispersion	Historical IRRs and scaling assumptions	Upside from climate tech scaling	Higher dispersion due to policy volatility	Extreme dispersion; stranded innovation risk
Real Estate Valuation	Income + appreciation models	Enhanced by adaptation investment	Adjusted for permitting delays, regulatory shifts	Adjusted for location-specific damage and insurance cost
Volatility Profile	Based on historical standard deviation	Slightly elevated due to transition uncertainty	Wider bands due to policy fragmentation	Highest dispersion due to systemic physical risk
Tail Risk Exposure	Typically under-represented	Mitigated by policy coordination	Elevated due to transition shocks	Elevated due to climate catastrophe scenarios
Time Horizon Fit	Long-term strategic (20Y)	Strategic planning and net-zero alignment	Tactical stress testing and risk budgeting	Long-term adaptation and resilience planning

Analysis: Scott Kalb, Director, RAAI at the Fletcher School

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Conclusions

- **This presentation is meant for illustration purposes and is not a recommendation to buy or sell any securities or indexes. It is meant to show that:**
- Asset allocators need a strong financial case, rooted in risk and return analysis, to justify investing in climate solutions and other system-level risks, especially in today's charged environment.
- Adjusting capital market assumptions (CMAs) to include climate change risks is a powerful way to make this case. CMAs are building blocks of portfolio construction used in asset allocation models.
- Current CMAs are based on historical trends and data, and do not reflect forward looking climate change impacts. This exposes portfolios to risk and damage.
- This can be seen by adjusting current CMAs using Network for Greening the Financial System (NGFS) tools, indicating forward returns will be lower and risks higher due to climate impacts.
- By the same token, asset allocators can use NGFS climate-adjusted CMAs to construct resilient portfolios that will outperform over time, helping to mobilize capital for solutions.
- Asset allocators should adjust their CMAs to include climate risks (or ask their providers to do so) and use these adjusted CMAs in their asset allocation models.

FLETCHER RESPONSIBLE ASSET ALLOCATOR INITIATIVE

PDI PRE DISTRIBUTION INITIATIVE

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GIC

The Inevitable Investment Opportunity: Climate Adaptation

Responsible Asset Allocator Initiative
Eleventh Roundtable
21 November 2025

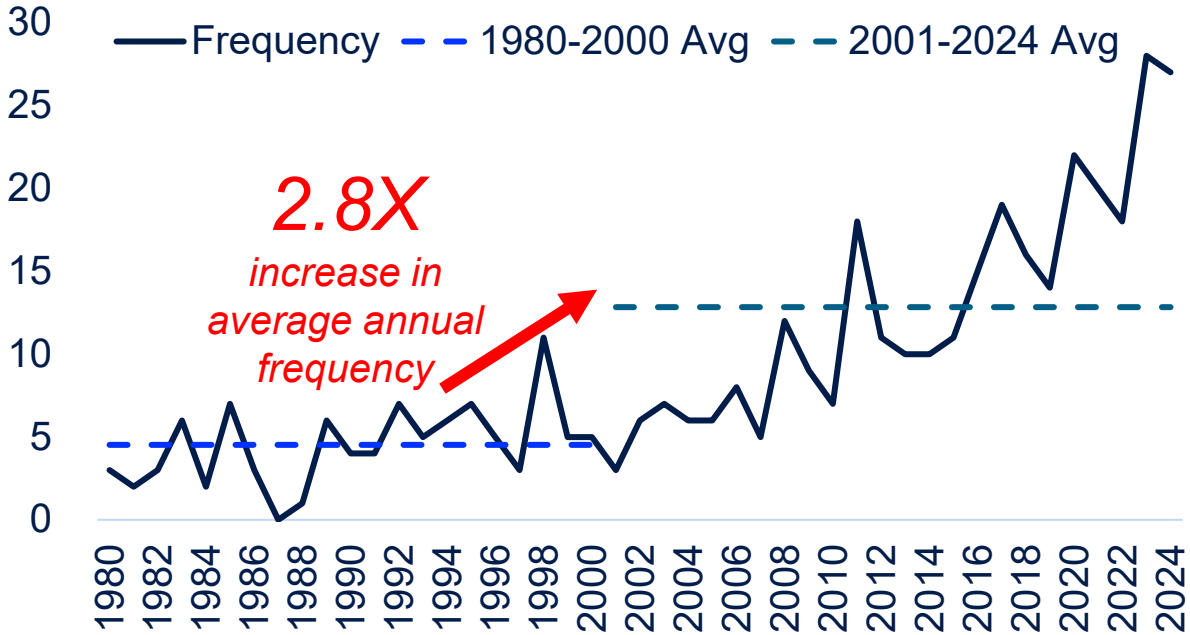
Presented by De Rui Wong
Senior Vice President, Sustainability Office

Agenda

1. Three reasons the climate adaptation theme is growing
2. Addressing two common concerns
3. Opportunities within the climate adaptation theme

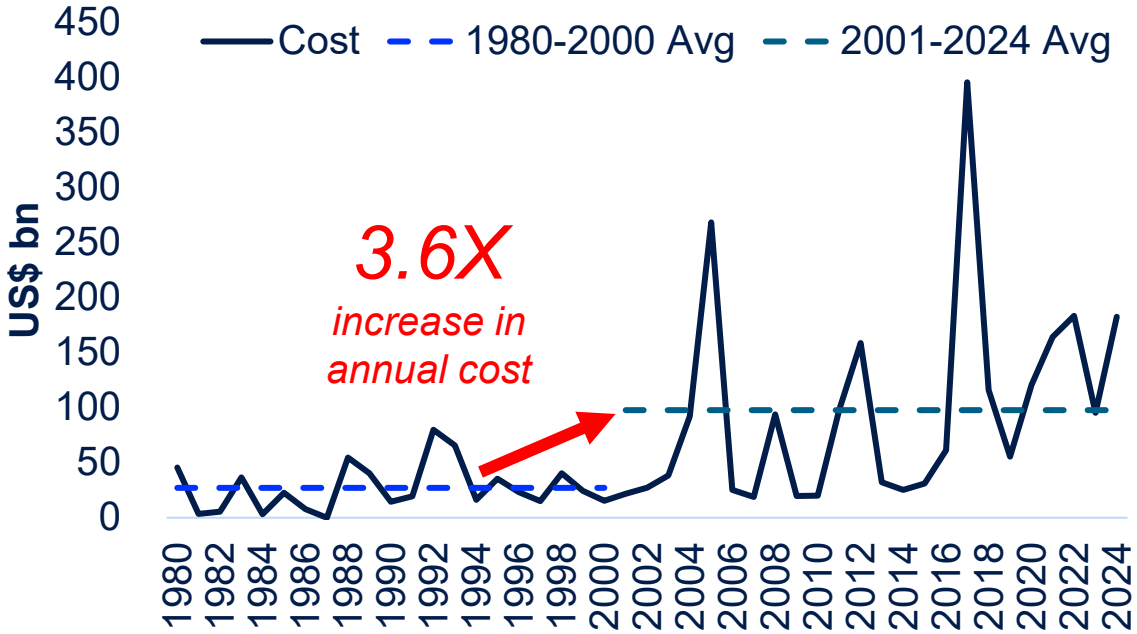
Paradigm shift in the frequency and severity of climate disasters

Frequency of CPI-adjusted US$bn climate disasters in the US



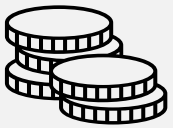
Source: NOAA

CPI-adjusted annual cost of US$bn climate disasters in the US



Source: NOAA

Enormous US$9 trillion investment opportunity by 2050

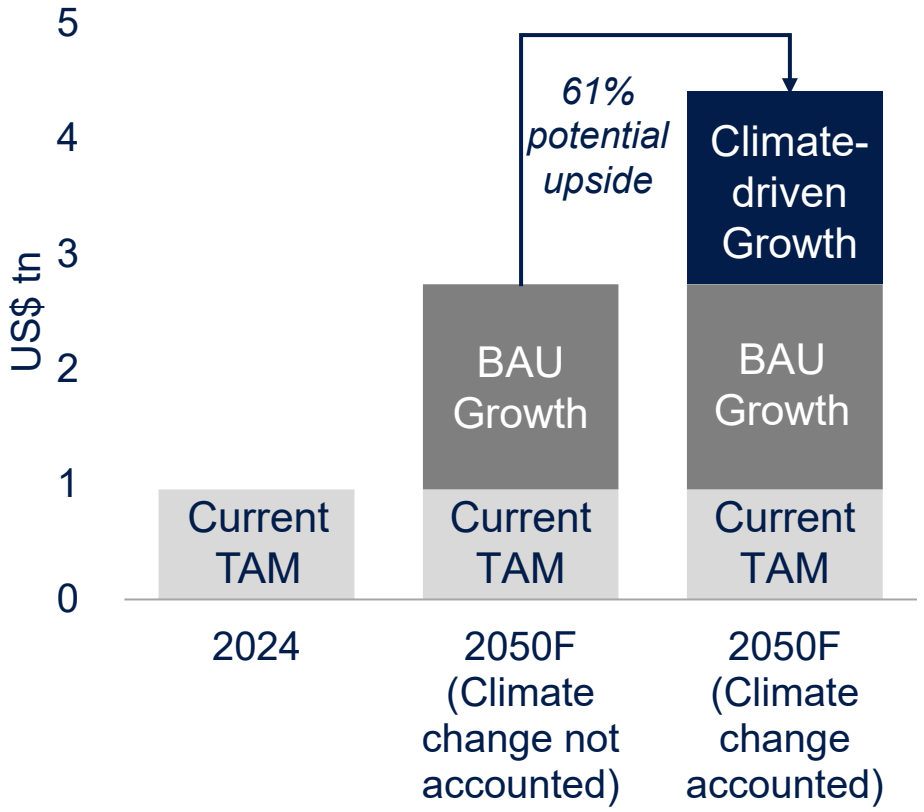
1.  **Hazard materiality assessment** — Out of 9 hazards (acute and chronic), we focused on **5**
2.  **Solution screening** — Out of >1,400 solutions we focused on **21**
3.  **Revenue TAM sizing** — We forecast revenue to grow from US$1tn today to **US$4tn by 2050**
4.  **Investment value sizing** — Enterprise value of these solution providers will go from US$2tn to **US$9tn by 2050**

Our proprietary climate elasticity of demand analysis shows unfactored revenue upside of 61%

Illustrative example of Climate Elasticity of Demand for *'Climate Hazard X'*

Impact on hazard frequency	Impact on hazard intensity	Relative exposure factor	Hazard damage pass-through rate	Climate Elasticity of Demand
1+0.2	1+1.0	0.5	0.7	49% increase
Next ºC temperature rise increases frequency of Climate Hazard X by 20%.	Next ºC temp. increases the intensity of Climate Hazard X by 100%.	Climate Hazard X typically occurs in regions with low population density, leading to lower levels of disruptions.	Due to lack of adoption of solutions to address Climate Hazard X, there's a higher level of economic impact pass-through	Each ºC temperature rise increases the economic impact of Climate Hazard X by 49%.

Base case climate adaptation revenue TAM

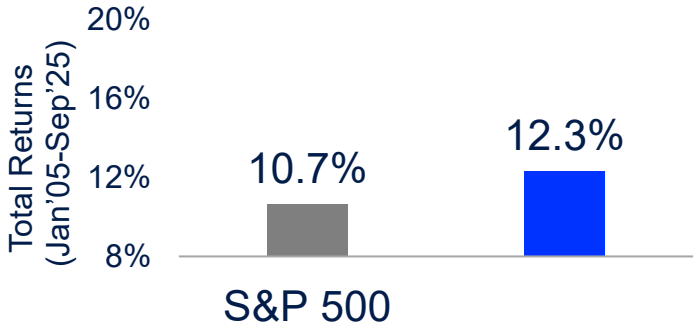


Source: GIC Sustainability Office, Bain & Company

Many climate adaptation solution providers are profitable businesses

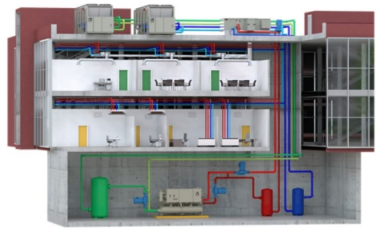
Flood-resilient materials

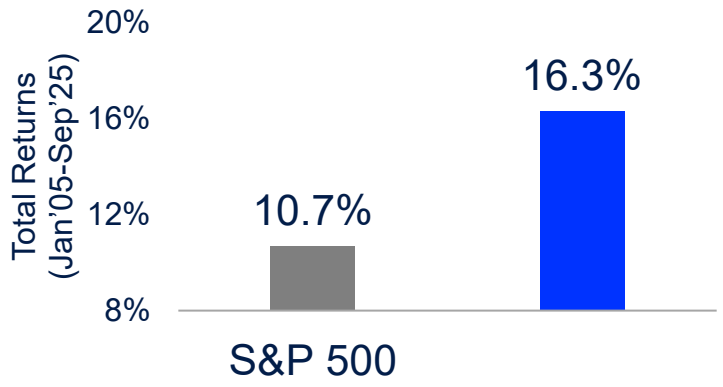
Waterproofing coatings, sealants, and membranes



Cooling systems

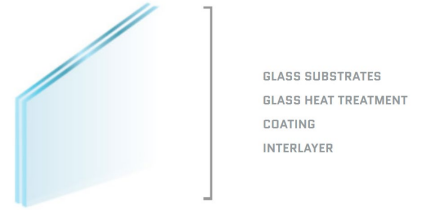
Residential and commercial cooling systems

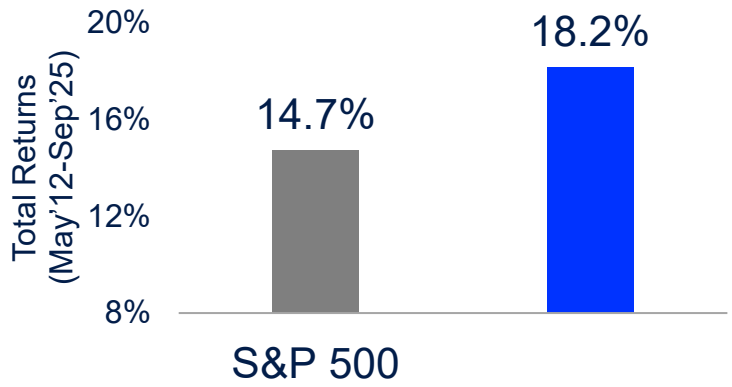




Wind-resistant materials

Impact resistant glass

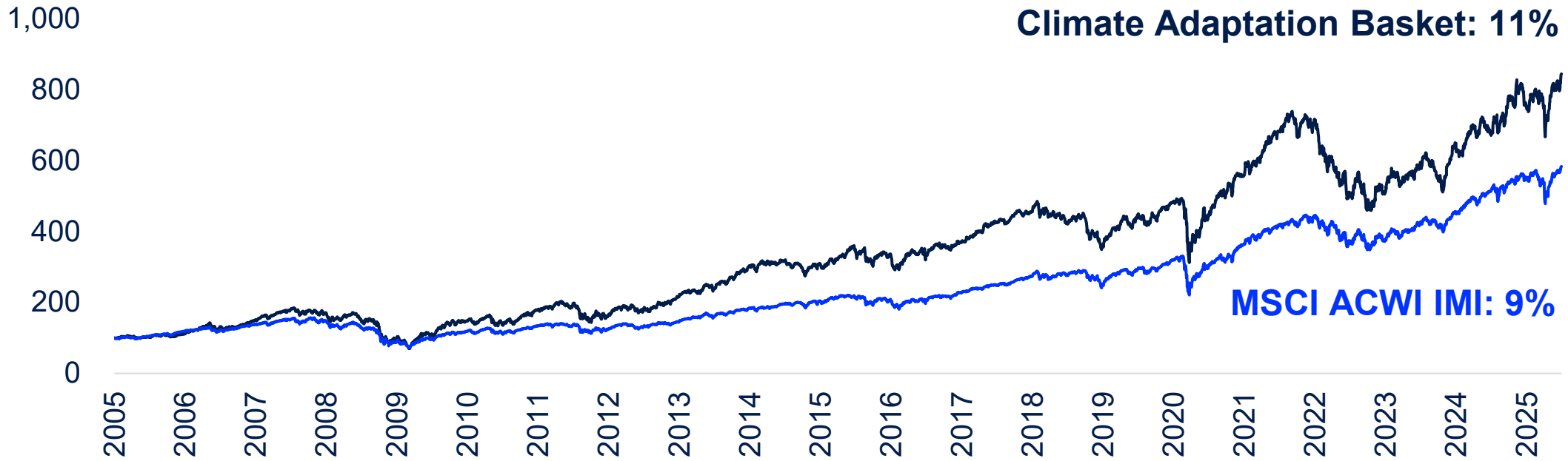




Note: Total returns for third company is shown from May'12 because that was the date of its US IPO.
Source: Bloomberg

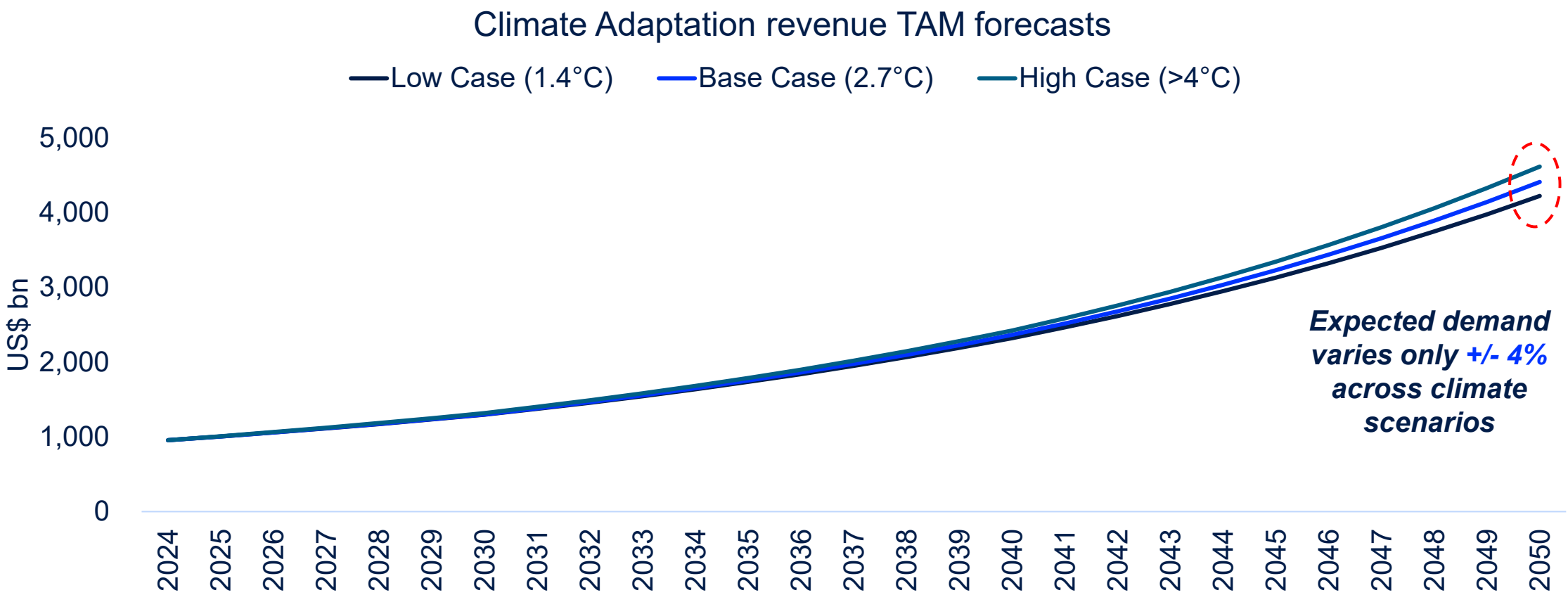
Returns have outperformed a global equity benchmark by 200 bps per year for the last 20 years

Total Returns – Climate Adaptation Basket vs. MSCI ACWI IMI



Note: Includes 107 companies with US$5mn ADTV and >50% revenue exposure to Climate Adaptation themes. Data as of 30 June 2025.
Source: FactSet, GIC Sustainability Office Analysis

Is the climate uncertainty too much for investors in this theme?



Source: GIC Sustainability Office, Bain & Company

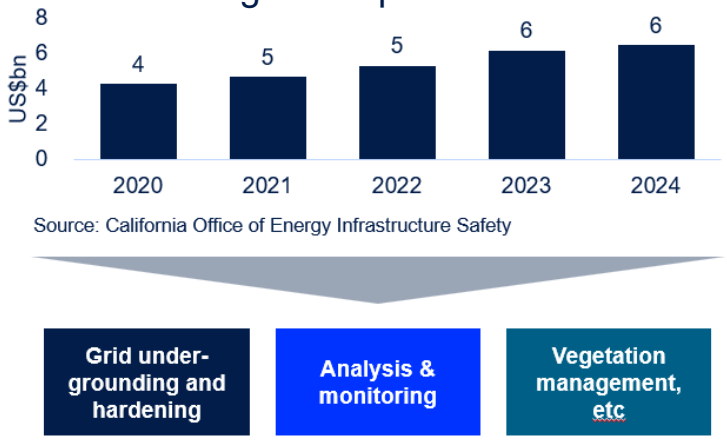
Is this theme dependent on government support?

Governments are big buyers of climate adaptation solutions...

Netherlands Delta Works Seawall system

…But corporates are also investing in climate adaptation to minimize business disruption

PG&E Wildfire Management Program Expenditures

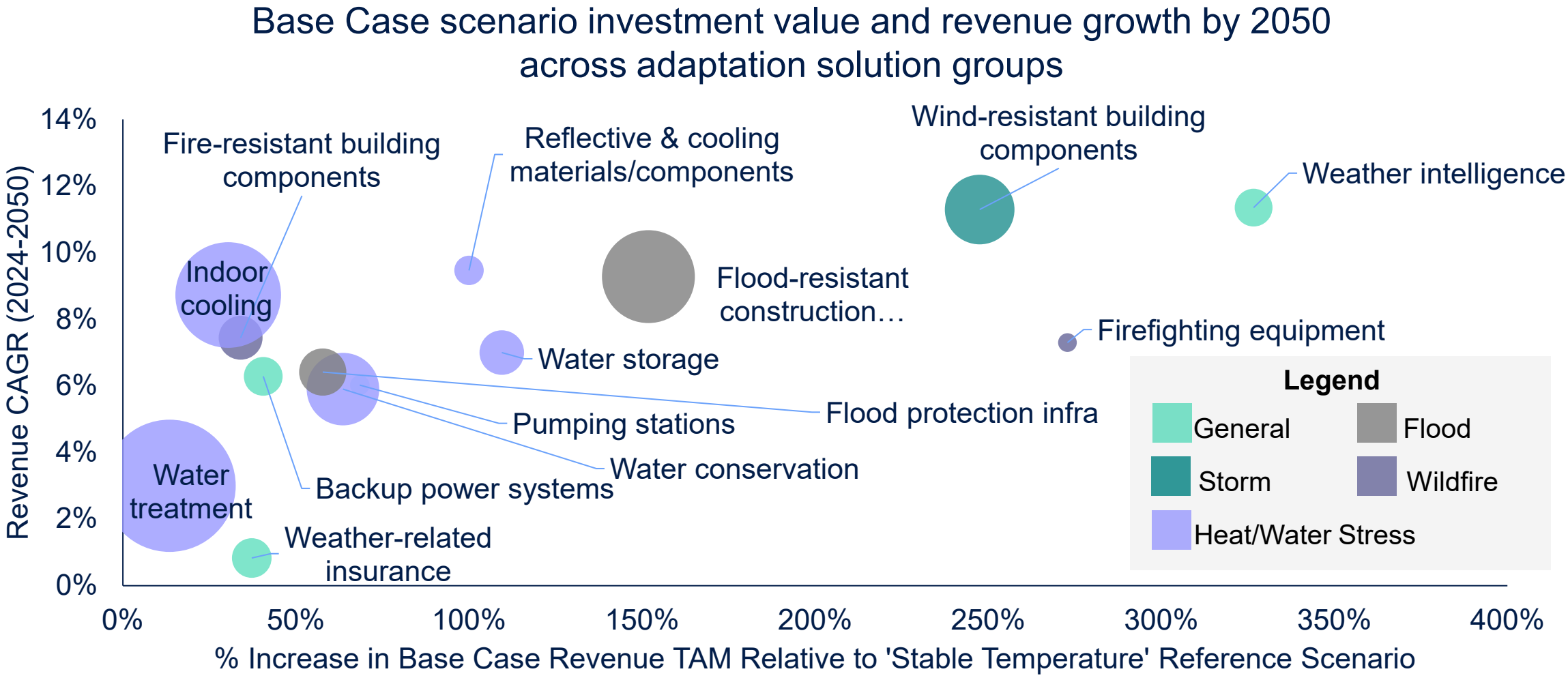


Source: California Office of Energy Infrastructure Safety

…and the solutions are technologically mature and accessible for households too

Florida home survives Hurricane Michael

What are the opportunities in the climate adaptation theme?



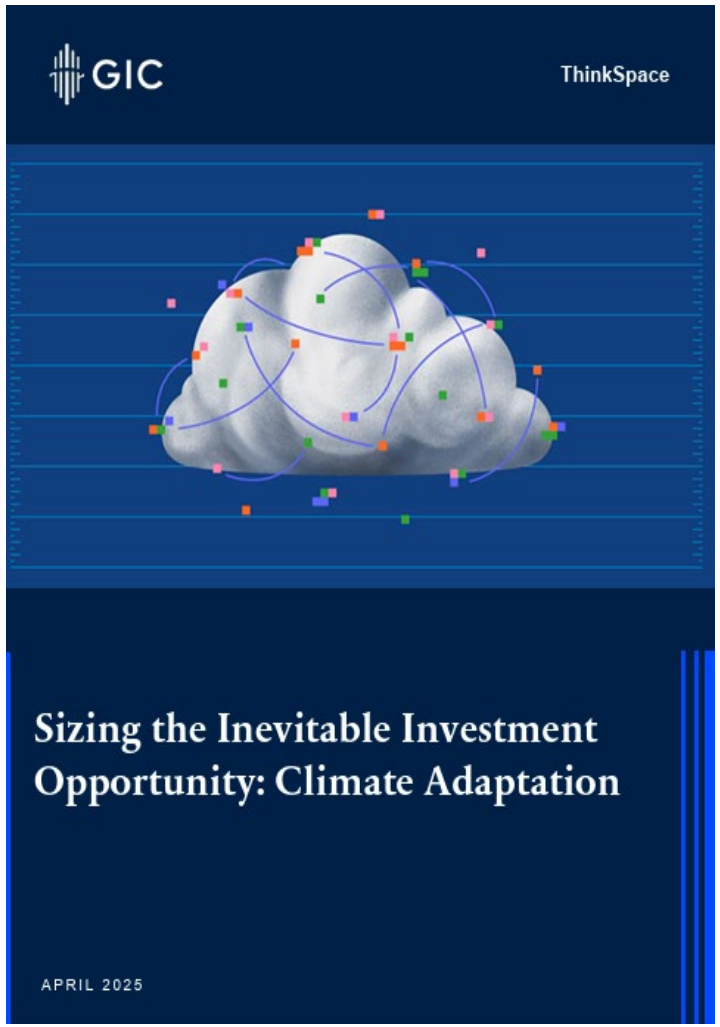
Source: GIC Sustainability Office analysis, Bain & Company

The time to act is now

Paradigm shift in climate disasters

$9trn investment opportunity by 2050 with substantial unfactored upside

Climate adaptation solution providers are profitable companies that have outperformed over the long term



GIC ThinkSpace Article on Climate Adaptation

Sizing the Inevitable Investment Opportunity: Climate Adaptation (May 2nd, 2025)

AI for Sovereign Investors: Integration into Investment Frameworks

Kristian Flyvholm, Chair & CEO

Singapore

21 November 2025

The Institute of Sovereign Investors

A historical AI transition impacting global investors

- Sovereign Investors manage $57 trillion in assets
  - SWFs: $14 trillion
  - Central Banks: $17 trillion
  - Public Pension Funds: $26 trillion

- Institute of Sovereign Investors recent research paper on AI
  - https://www.sovereign-investors.com/publications/ai-for-sovereign-wealth-funds-integration-into-investment-frameworks

"The best way to predict the future is to create it."
Peter Drucker

The Institute of Sovereign Investors

Research Paper 3/2025: AI for Sovereign Wealth Funds - Integration into Investment Frameworks

Authors:
Dr. Guan Seng Khoo, Reza Mahmud and Kristian Flywholm[1]

Date: *21 September 2025*

ABSTRACT: *This research paper outlines how Artificial Intelligence (AI) is fundamentally reshaping the investment policy, strategies and operational efficiency of Sovereign Wealth Funds (SWFs), who manage $14 trillion in assets in an increasingly complex landscape. SWFs are leveraging AI to enhance decision-making, optimize portfolios, and gain a significant competitive edge and operational efficiency. Key strategic benefits include:*

- ***Gaining a Long-Term Competitive Edge**: Leverage predictive analytics and agentic AI to identify investment opportunities and risks far earlier than traditional methods allow, leading to potentially enhanced risk-return and total performance, while strengthening real-time analytics, investment implementation and proactive risk management.*
- ***Achieving Operational Alpha**: Reduce operational risk and enhance efficiency by deploying AI agents to automate research, due diligence, compliance monitoring, and portfolio rebalancing.*
- ***Strengthening Governance and Resilience**: Implement sophisticated, real-time risk modeling that provides key decision-makers with enhanced and real-time oversight that builds a more robust, resilient portfolio capable of withstanding market shocks and adverse scenarios.*

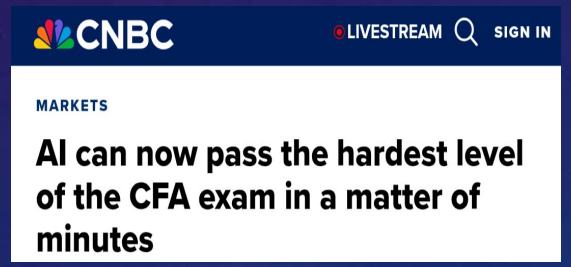
A successful transition requires a deliberate, phased, and well-governed strategic approach. The SWFs that strategically embed AI into their investment and operational frameworks may secure a decisive competitive advantage and be better positioned to navigate the future. More research in this area is needed as AI is evolving rapidly. We look forward to contributing to this journey with more research as well.

1. Strategic Imperative

AI is fundamentally reshaping how $57 trillion in sovereign capital is managed

Core Benefits

- **Long-Term Competitive Edge:** Predictive analytics identifying opportunities faster than traditional methods
- **Operational Alpha:** Automation driving efficiency beyond gross returns
- **Enhanced Governance:** Real-time risk modeling and portfolio resilience



JPMorgan reduced lawyers' hours by 360,000 annually by automating loan agreement analysis with machine learning software COIN

2. AI Application Across the Investment Chain

A. Data Analysis & Insights

- Processing structured and unstructured data at unprecedented scale
- Ambient agents monitoring markets 24/7, flagging opportunities
- Sentiment analysis from news, social media, employee reviews

B. Portfolio Management Revolution

- Real-time visibility into external manager positions
- Dynamic optimization based on changing correlations
- Automated rebalancing with liquidity and cost optimization

C. Risk Management Transformation

- Pre-trade compliance checks preventing breaches before they occur
- Continuous stress testing vs. periodic reviews
- Proactive alerts replacing reactive reporting

3. Agentic AI Framework: Operational alpha

I. Macro Research Agent

- Traditional: 80% data gathering, 20% analysis (AI reverses that)
- Macroeconomic models and capital market assumptions can be now-casted and monitored in real time
- Financial data can be analyzed and predicted real time
- AI using alternative data (satellite imagery, shipping information, factory output, parking lots in city centers)

Result: More and/or better research.

II. Front office: Portfolio Manager Assistant (Agent)

- Portfolio teams gets additional "assistants"
- Investment universe can be screened real time
- The efficient frontier can be more often updated - perhaps real time
- Portfolio inefficiencies and factor risks identified as markets change

Result: Portfolio managers gets more efficient and can make better deals.

III. Middle Office: Risk & Compliance Agent

- Pre-trade compliance automation
- Real-time mandate monitoring
- Instant stress scenario modeling
- First drafts of compliance reports (for review)

Result: Breaches prevented, not just reported. Cost savings.

IV. Middle Office: Rebalancer agent

- Micro-trades executed continuously vs. quarterly big moves. Optimizes for liquidity windows and transaction costs
- Reduces tracking error automatically

Result: Cost of rebalancing reduces.

V. Back Office Agent

- Predicts settlement failures before they occur
- Resolves trade discrepancies autonomously
- Optimizes collateral management

Result: Frequency and cost of errors reduces with much less claims.

4. Real-World Implementation: Insights & Case Studies

Case Study Context

- Drew insights from leading SWFs through our network
- Common themes emerging across thought leaders

AI Investment Committee Member (new concept)

- AI as IC Secretary & “Chief Whip”: Meeting prep and minutes, but also addressing “behavioral flaws”
- Pre-meeting voting to reduce groupthink - allows contrary views to be heard
- Post-decision tracking of member "hit ratios" - AI studies if groups or individuals are good decision makers!
- Uncomfortable but potentially transformative - rewards can be aligned. IC can give room to “rising stars”
- **Key Lesson:** AI augments human judgment, does not replace it

AI at NBIM

- Challenge: Processing massive, diverse daily information (market data, research, ESG reports)
- Solution: Deployed AI enterprise-wide, training 600+ employees in two months
- Key Use Cases: Accelerating research synthesis, risk assessment, automating compliance documentation, and enabling business users to build their own analysis tools.
- Impact: Achieved a 20% average time saving per employee on weekly tasks

5. Critical Success Factors

2025 MIT research found 95% of AI organisational initiatives have failed - but why?

Foundations

- **Data Strategy:** Quality, governance, security first
- **Model Development:** Right tool for each use case
- **Human-AI Collaboration:** Augmented intelligence, not replacement

Challenges

- Data quality and cleaning
- Model interpretability and explainability
- Cybersecurity and uncontrolled AI actions
- Need for human accountability and rationalization

Phased Approach Required

- Deliberate strategy
- Robust governance framework
- Continuous learning culture

6. Key Takeaways

AI integration is **not optional** - it is existential for competitive positioning

- **Operational alpha** is as important as traditional alpha (but without tracking risk)
- Success requires **strategic, phased, well-governed** implementation
- The SWFs that lead this transformation will secure **decisive advantages**
- Think ahead: AI evolving fast, where could it be in 1-3y time? Regulations, costs, energy use, geopolitics etc
- Human imagination and accountability are still important going forward, and AI reflects human biases
- AI is a powerful leverage and leveller of human capabilities for SWFs which have challenges to attract global or develop local talent esp in emerging countries.

Call to Action

- This is an evolving field requiring ongoing research and peer learning
- The journey is challenging, but the competitive gap for those who hesitate will be significant

Final Thought

"The question is not whether to adopt AI, but how quickly and strategically you can integrate it while maintaining the human judgment that sovereigns require."

Q&A

The Institute
of
Sovereign Investors

Appendix

The Institute
of
Sovereign Investors

The Institute of Sovereign Investors: Shaping Institutional Resilience and Global Best Practice

Who are we?

- A unique global Institute with deep and diverse sovereign experience and academic achievement, dedicated to advancing learning and thinking around institutional resilience, sovereign strategy, and governance.
- We embrace experience and long-term thinking by excelling frameworks and thoughtful sovereign actions for this and future generations.

What do we do?

- We are a global eco-system that connect sovereign decision-makers to a worldwide network of expertise and knowledge partners that brings about institutional resilience and capabilities for global excellence in the execution of sovereign decisions.
- We move from recommendations to implementation and offers mentoring, sounding boards and senior advisory that allow decision-makers to excel even when resources are constrained, and tasks are plentiful.

A Millennium of Work Experience

Who We Are: International Advisory Council

12 PhDs, 20 CEOs, CFOs & CIOs

Legal & Policy Experts

- Dr. Niels Thygesen, Professor Emeritus, Copenhagen University. Ex Chair of European Fiscal Board. Ex Harvard, OECD, Danish Economic Council & Central Bank
- Dr. Paul Rose, Dean & Professor, Case Western Reserve University School of Law
- Dr. Ehab Elsonbaty, Partner, DLA Piper and Qatar Investment Authority
- Winston Ma, CFA & Esq, NYU School of Law and Executive Director of GPIFF. Ex-China Investment Corporation
- Dag Detter, Principal, Detter & Co, Ex McKinsey, BCG
- Sven Otto Littorin, Former Swedish Minister of Employment & Chairman
- Dr. Hubert Danso, CEO & Chairman, Africa Investor
- Dr. Jürgen Braunstein, Assistant Professor, Vienna University of Economics. Ex Harvard University.

Leadership & Investments

- Dr. Paul O'Brien, Former Deputy CIO of ADIA & Trustee, Wyoming Retirement System
- Kristian Flyvholm, MBA. CEO. Ex IFSWF, IMF, ECB and 4 times CIO
- Eugene O'Callaghan, Ex-CEO Ireland SWF
- Herald Bonnici, Ex-CEO of Malta Government Investments
- Ana Nachkebia, CFA. Acting CIO, Georgia Pension Fund
- Scott E. Kalb, Ex-CIO of Korea Investment. Chair, Sovereign Investor Institute
- Niclas Hiller, Ex-NBIM, External Manager Group and CIO of Formue, Norway
- Dr. Demir Bektic, Head of Asset Solutions, Commerzbank. Adj. Professor of Finance
- Philipp A. Schoeller, MSc and MBA. Founding Partner of GenCap. Global investor, entrepreneur and philanthropist

Institutional Resilience

- Robert "Bob" Barnden, Ex CEO of PwC, Saudi Arabia and Partner, PwC, Sweden
- Nic Winterstorm, Ex-NBIM, Stanford and University of California
- Susan Daniel, CRO, Oman SWF, ADQ, PwC
- Arif Shaikh, Sr. Risk Advisor , CBUAE and Group Chief Risk Officer, FAB
- Dr. Celeste Lo Turco, Ex PwC, NEOM, Saudi Investment Bank
- James Hewitt, Ex Sr. Regional Director, Deloitte and Board Advisor to EUREX
- Karina Luchinkina, Ex PwC, Board Advisor
- Reza Mahmud, Ex Brunei Investment Agency, Aviva Life & Pensions, PwC
- Vitaly Veksler, CFA, CEO of Beyond Borders Investment Strategies
- Frank Scheidig, Head of Sr. Executive Banking, DZ Bank

Excellence and Best Practice

- Catherine Savage, Ex Chair of the Guardians of the NZSF. Board Chair and CEO roles.
- Seema A. Khan, Visionary Leader in Economic Strategy & Investment Innovation
- Dr. Patrick J. Schena, BLR Professor of Practice, Tufts University, Fletcher School
- Olivier Rousseau, Ex-Chair of French Pension Reserve Fund
- Dr. Massimiliano Castelli, MD, Head of Strategy, Sovereign Institutions, UBS
- Dr. Yogesh Khatri, Ex-GIC, IMF and Ass. Professor, Nanyang Business School
- Dr. Guan Seng Khoo, Ex-Temasek, SGX, AIMCo
- Gilbert Nyatanyi, Lawyer. Ex-CEO Agaciro Development Fund

What We Do:
Strategic advice and capability development

Institutional Resilience

- Board Assignments
- Strategy & Transformation
- Best practice (IFSWF, IMF, World Bank, BIS, OECD)
- Benchmarking & Peer Analysis
- KPIs: Analysis, Decision, Oversight and Execution

Talents & Teams

- Sovereign Investors Academy
- Global Events & Roundtables
- Workshops & Mentoring
- Advancing Institutional Capacity
- Partnership & Networks with Global Stakeholders

Thought Leadership

- Governance and Institutional Best Practice
- Climate Change, Development & Resilience
- Institutional Arrangements for Investment and Risk Management
- Research and Innovation in Investment & Risk Management

Investment & Risk Management

- Investment Policy & Strategic Asset Allocation
- Portfolio Construction & Execution
- External Manager Policy: Selection, Oversight and Actions
- Outsourced CIO/CRO/CFO (advisory)
- Investment Committee: Structure and Independent Members

Our Global Experience:
We've built, led and advised sovereign institutions

International Institutions

OECD

International Monetary Fund

World Bank Group

European Central Bank

IFSWF
International Forum of Sovereign Wealth Funds

OMFIF
Official Monetary and Financial Institutions Forum

Major Universities

Harvard

University of Cambridge

University of California

Nanyang Technological University Singapore

Northwestern University

Tufts University | The Fletcher School
The graduate school of global affairs at Tufts University

NYU

Chicago Booth
The University of Chicago Booth School of Business

Sovereign Investors

Temasek

ADIA
جهاز أبوظبي للاستثمار
Abu Dhabi Investment Authority

Norges Bank Investment Management

GIC

KIC
Korea Investment Corporation

中国投资有限责任公司
China Investment Corporation

NZSuperFund
Te Kaitiaki Tahua Penihana Kaumātua o Aotearoa

QIA
جهاز قطر للاستثمار
Qatar Investment Authority

AIMCo
Alberta Investment Management Corp.

Ciste Infheistiochta Straitéisí d'Éirinn
Ireland Strategic Investment Fund

مصرف الإمارات العربية المتحدة المركزي
Central Bank of the U.A.E.

جهاز الاستثمار العُماني
Oman Investment Authority

آكينسي فلاءبرن بروني
Brunei Investment Agency

საქართველოს საპენსიო ფონდი
Pension Fund of Georgia

القابضة

Note: These are some of the places, where our IAC have worked – we do not suggest affiliation.

DISCLAIMER

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For tailored guidance, we welcome further discussions.

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