Action on Climate Change and New Approaches to Growth:
Marking the 20th Anniversary of the Stern Review

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October 2026



The origins and the reception



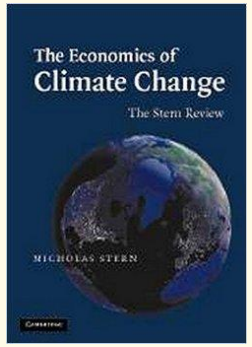
Credit: Kieran Doherty/AP/Alamy via Nature (2026)

- **The Gleneagles G8 Summit of July 2005:** Africa + climate.
- **Progress on Africa:** Agreement to double aid by 2010 + plan for debt relief.
- Founded in analysis, report of Commission for Africa, and social pressure "Make Poverty History".
- **Little progress on climate.** Reflection afterwards on causes: lack of familiarity of leaders with subject; minimal economics presented; absence of social pressure.
- **Decided to launch the Review** (Gordon Brown and Tony Blair); assembled team over summer. Team from across government with some outside recruitment; located in UK Treasury.

- **Launched 30th October 2006** at Royal Society (platform TB, GB, David Miliband, President of Royal Society (Martin Rees) + me.
- **Reception.** Wide reporting across world. Creation of Stern dissemination team.
- **Some attacks** around "alarmist" and "discounting"; mostly confused and mistaken (see below).

From The Stern Review to The Growth Story of the 21st century

(2006)



The central conclusions of the Stern Review stand. Indeed are still stronger.

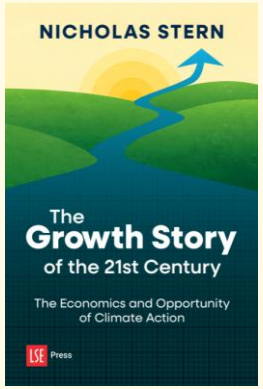
(1) 'the benefits of **strong and early** action far outweigh the economic costs of not acting' (p. xv).

(2) the 'world does not need to choose between averting climate change and promoting growth and development' and 'tackling climate change is the **pro-growth strategy** for the longer term' (p. xvii).

(3) 'climate change is the **greatest market failure** the world has ever seen' (p. xviii) and a 'range of options exists to cut emissions; strong, deliberate **policy action** is required to motivate their take-up' (p. xvii).

We are now going beyond comparing the cost of inaction with that of action. We are setting the question differently. Inaction would be catastrophic. Action is a dynamic new growth story. The question now is the "what" and the "how".

(2025)



What has changed:

1. **Risks: ever more worrying**
2. **Economics: evolving understanding**
3. **Technology: moving fast**

The way forward:

4. **The growth story**
5. **Foster necessary investment and structural change. Tackle barriers in society and politics and engage more effectively in a contested politics**

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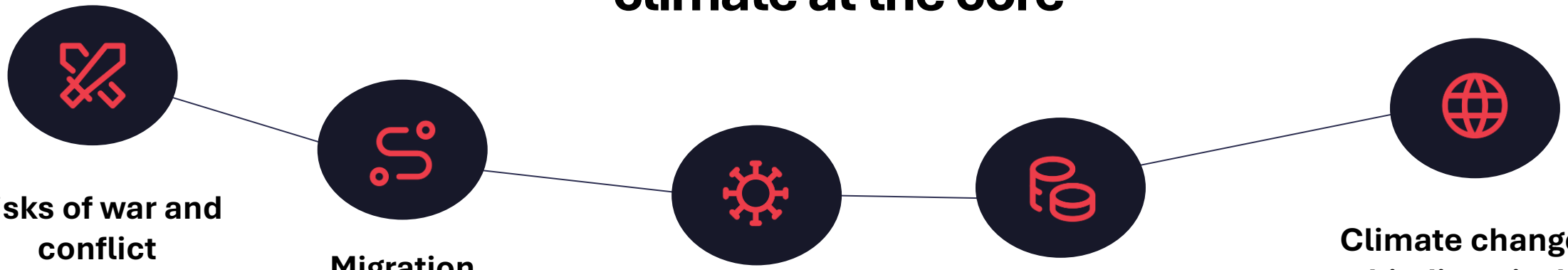
Rising interconnected risks: climate at the core



Risks of war and conflict

Driven, inter alia, by territorial ambition, competition for resources, and ever deadlier weapons. Compounded by climate change.

Migration pressures

Demography, environmental degradation, and conflict compounding each other.

A future pandemic

High probability in any two-decade period. Risks increased by climate change.

Strained public finances

High debt-to-GDP ratios and high real interest rates. Link to pandemic and extreme events.

Climate change and biodiversity loss

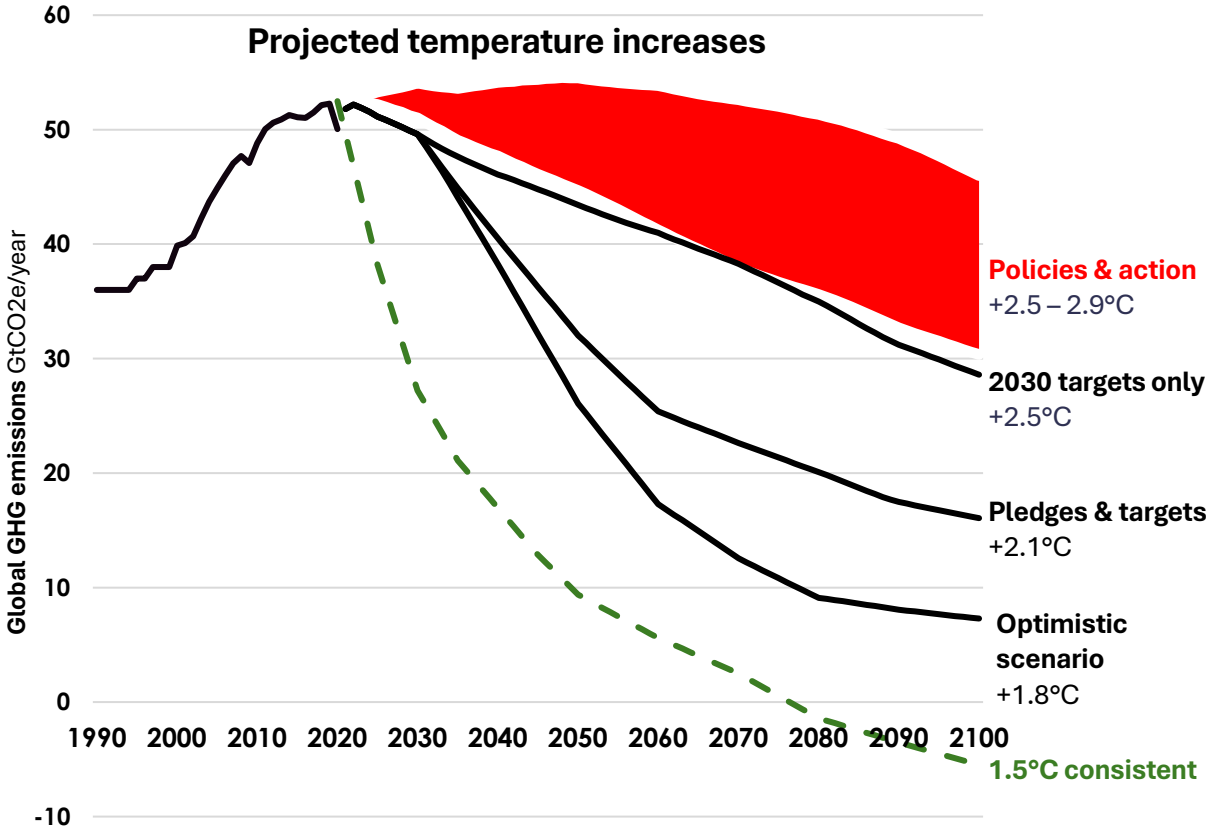
The next two decades are decisive, particularly with regards to potentially devastating tipping points. **1.5°C will be passed soon. But staying below 2°C is still possible with the right investment. And should keep the possibility of eventually returning to 1.5°C alive.**

Rules-based systems have weakened sharply, particularly around trade and conflict, and **the spirit of international collaboration has been deeply damaged.** But **collaboration remains crucial** to overcoming these challenges.

AI and changing **demography** sources of further pressures and risks.

Climate risks: ever more worrying I

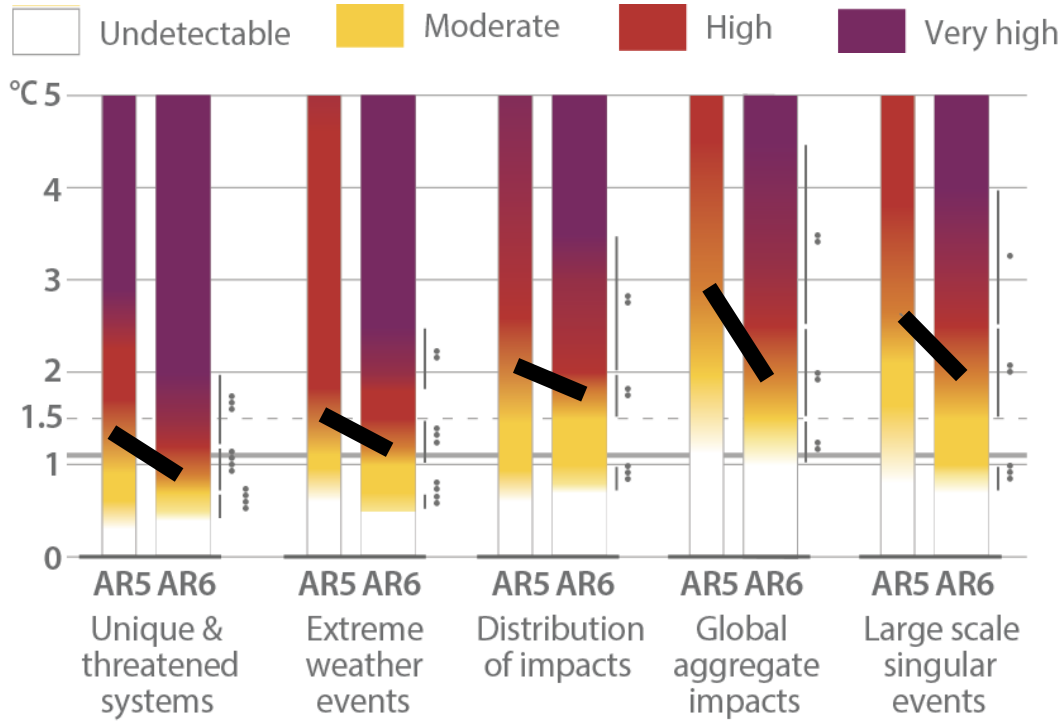
Under current policies, temperatures are headed to potentially catastrophic warming of close to 3°C by 2100. And 2°C by the 2060s.



Source: Climate Action Tracker (2023), December 2023 update

The more we learn, the worse it looks: as emissions go on rising and the science advances, the evidence gets ever clearer and more worrying. The need for strong and urgent action is ever more intense.

Risk/Impact: Global reasons for concern in AR5 (2014) VS AR6 (2022)



Source: IPCC (2023), via Rogelj (2025)

Our planet has not experienced average temperatures that are 3°C higher than pre-industrial level for around 3 million years.

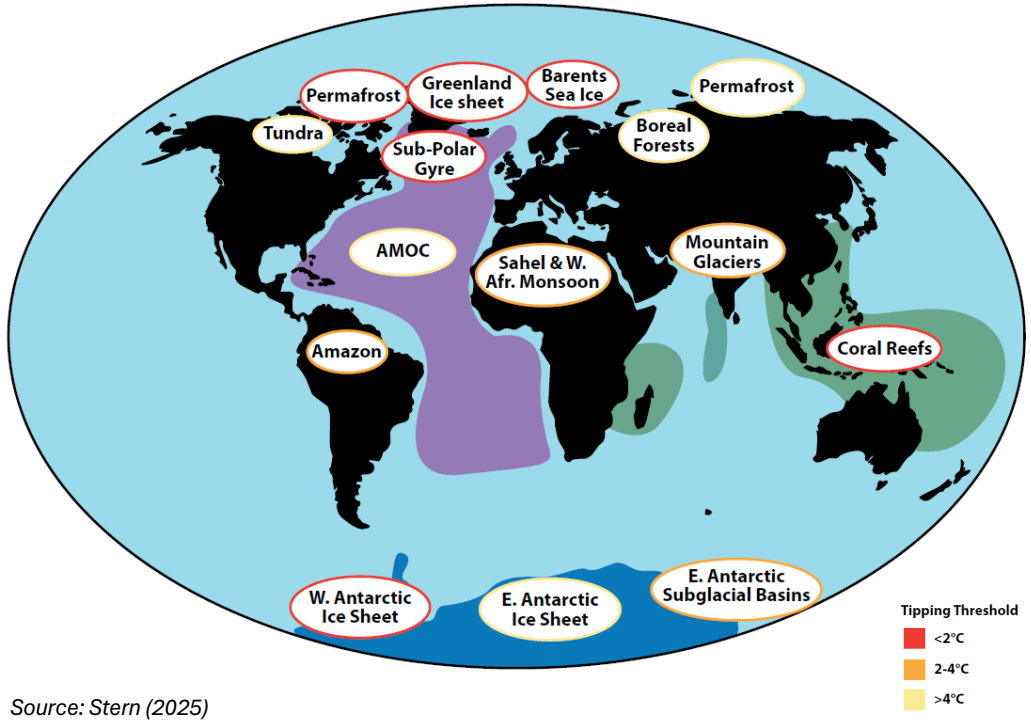
Sea levels were then 5–25 metres higher than today (Miller et al., 2012; IPCC, 2023). Humanity has developed and lived in the Holocene period (roughly last 12,000 years) in a fairly stable climate and temperature, mostly in the range +/- 1°C, relative to the end of the 19th century. Failure to act could result in large parts of the world becoming unliveable or very hostile and result in large movements of people. Likely risk of major conflict.

Climate risks: ever more worrying II

We will only stop the impacts of climate change when we stabilise concentrations and reach net zero globally

Tipping points would create powerful dynamic feedbacks, rapid temperature increases, instability, and environmental catastrophes.

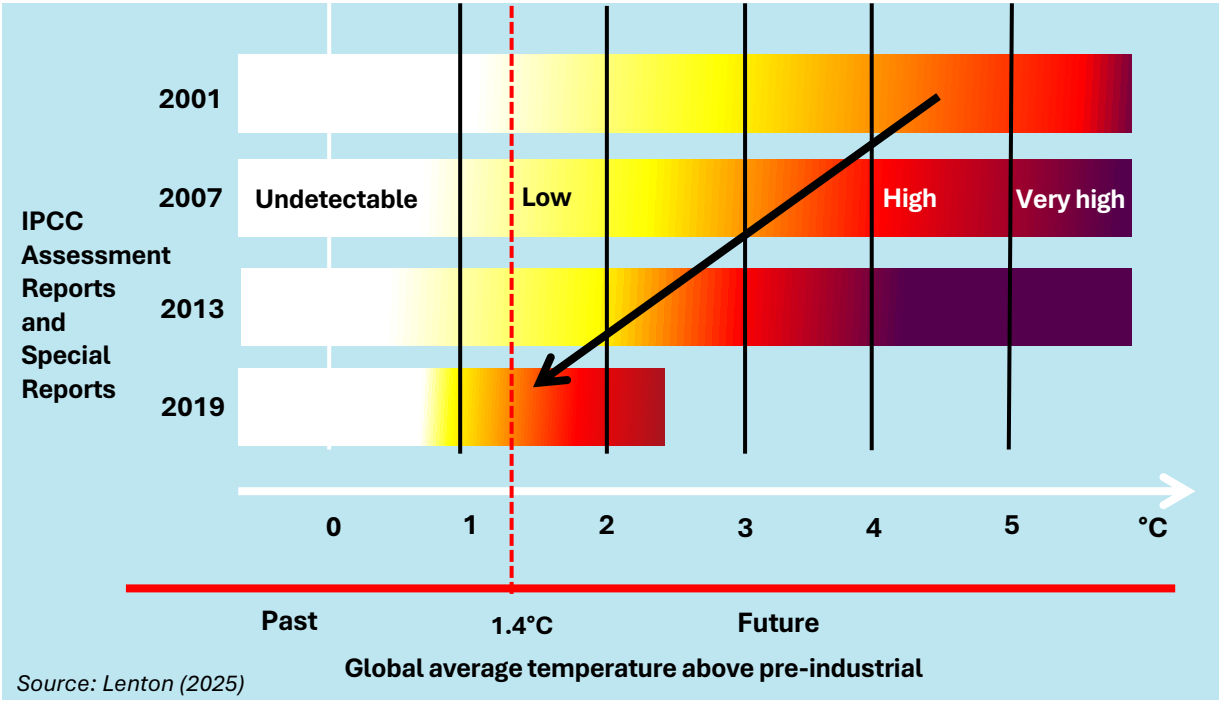
Climate tipping elements and their sensitivity to global warming



Source: Stern (2025)

At the time of the Stern Review (2006), the latest IPCC report was AR3 (2001). The risks of tipping points are now much higher than we envisaged then. They now appear possible and likely around 1.5°C to 2.5°C.

Changing risk assessment of tipping points



Source: Lenton (2025)

Tipping points concern failures of or collapse in: ice sheets, coral reefs, permafrost, Amazon forest, AMOC…
Potentially devastating and unstable outcomes. Some of these changes may be very difficult, or impossible, to reverse.
Further, triggering one tipping point could trigger another, potentially setting off further dangerous dynamic instabilities.

NET ZERO IS REQUIRED TO STABILISE CONCENTRATIONS AND THUS TEMPERATURES. BASIC PHYSICS.

Extreme events have immense impacts on lives and livelihoods, as illustrated in the following events I

(current warming: 1.34–1.41 °C compared with 1850-1900 (WMO, 2025))

The physical impacts of climate change directly affect economic activity, for example in agriculture, and destroy property and livelihoods, for example, in floods and wildfires. Impacts propagate throughout human and natural systems, altering their equilibrium and generating disruption, disequilibrium, and instabilities. They can set back development by decades.



VILLAMOR VISAYA/AFP via Getty Images

Nearer the **end of 2024**, Super Typhoon Man-yi hit the Philippines. The image shows submerged homes at a village in Ilagan, Isabela province, in November 2024, due to continuous heavy rains from this typhoon.



David Carbajo/Nur Photo via Getty Images

In **January 2025**, the massive Palisades and Eaton wildfires in Los Angeles, California, engulfed more than 16,000 structures. Many lives, homes, and businesses were lost. Some were insured, some were not. Future insurance will be very expensive or unobtainable.

Extreme events have immense impacts on lives and livelihoods, as illustrated in the following events II

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"A very strong El Niño [mid-2026 to early-2027] can significantly shift rainfall and temperature patterns worldwide and fuel extreme weather" (WMO, 2026)



After months of drought and extreme heat periods, Western Europe experienced widespread, intense wildfires during the summer, for example, severely affecting parts of France and Spain in **July 2026** (WWA, 2026).



In August 2026, cascading hazards in Nepal led to more than a thousand deaths (UN, 2026). The initial event seems to be a massive landslide (Science, 2026). This event is recent, and with that, the analysis of its occurrence. More generally, the IPCC (2019) has linked the retreat of mountain glaciers and mountain permafrost thaw to decreased mountain slope stability.

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The narrow economics of climate change

Important strands in received economics have been unhelpful and misleading. These approaches shoehorn immense risks into models of modest disturbances around steady growth and assume away key issues of impact and response. **Much of early policy discussions focused almost exclusively on GHG emissions as an externality, and saw the corrective role of Pigouvian taxes as providing nearly all the policy response necessary.**

Misleading models

Growth impervious to climate change

No recognition of possibility of serious derailment or disruption

Risks trivialised

A few % of GDP even at 4–5°C; no cascading failures, tipping points, or compounding

Costs overstated, technical progress modest

No scale economies or rapid technological change, contradicting experience

Limited structural/systemic change

Yet, major systemic shifts are central to an effective response

Other key market failures:

1. **R,D&D:** Ideas' social value not captured; discoveries produce public goods
2. **Capital markets:** Imperfect and asymmetric information and risk assessments
3. **Networks & systems:** Coordination failures in energy, transport, cities, land, water
4. **Information:** Lack of awareness of technologies, actions, or support
5. **Pollution & co-benefits:** Benefits of eliminating fossil fuels often ignored in health, ecosystems, biodiversity. Air pollution a major killer.

Carbon pricing is indeed a crucial part of policy.
But it does not, alone, redesign city, energy, transport, land, or water systems, or deal with other key market failures.

Discounting: understanding inter-temporal valuations

Decisions made now affect lives and livelihoods, and the risks faced, in the future. Intertemporal valuations are central. Economics has been far too casual and simplistic about discounting and valuations applied to future impacts. There has been ignorance or ignoring of both ethics and modern public economics.

Fundamentals of discounting: the definition of discounting and the relevant social values

Social discount factor

The relative social valuation of an extra unit (e.g. of consumption) in the future, relative to an extra unit now.

Social discount rate

The proportional rate of fall of the social discount factor.

The valuation of an extra unit at time *t* will depend, for most ethical observers, on:

I. The levels of living of those at time *t* relative to now

High valuation if future generations are likely to be poor; low if they are likely to be rich.

II. The valuation of a future life (or utility) relative to one now

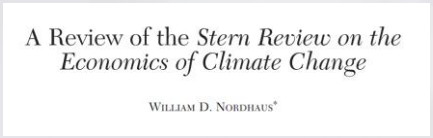
'Pure-time discounting' embodies valuations which discriminate by date of birth across individuals even if their positions are otherwise identical. Hard to provide a serious ethical argument in favour of pure-time discounting.

Discounting is endogenous because it is shaped by decisions now. Discount rates cannot simply be "imported" from outside the analysis. If climate action is weak or slow then future generations could be poorer and discount rates could be negative over some periods.

THE ABOVE IS THE BASIC LOGIC APPLIED IN THE STERN REVIEW AND REMAINS SOUND. MUCH OF THE COMMENTARY WAS NOT (SEE NEXT SLIDE).

Discounting and risk: a muddled history in economics

In retrospect, the following quote from Bill Nordhaus' review of the Stern Review is shockingly mistaken:


A Review of the *Stern Review on the Economics of Climate Change*

William D. Nordhaus*

"The Review's unambiguous conclusions about the need for extreme immediate action will not survive the substitution of assumptions that are consistent with today's marketplace real interest rates and savings rates."

(Nordhaus, 2007, p. 686)

Three major mistakes in one quote

1. It is not "extreme" to turn away from a cliff-edge and invest in an attractive new path. Given the risks, it can be seen as reckless not to turn.

2. It misunderstands discounting. Three misunderstandings here: (a) social discount rates are endogenous, they cannot simply be "imported" from outside; (b) markets do not carry social values; (c) and even if they did, capital markets are highly imperfect and do not reflect either private or public marginal valuations.

3. It overstates the importance of discounting relative to risk in this context.

Five mistakes, if we decompose the second into its three elements.

In retrospect, the Stern Review, far from overstating risks or being "alarmist", understated the risks.

Both ethical values and risk play key roles, but we now see risk as ever more important, and impacts ever more severe and closer in time.

The case for urgent action is now mostly driven by the magnitude of future risks; of a magnitude likely to dominate any reasonable or well-founded discounting (see Stern, AER, 2008). And discounting itself must recognise significant probabilities of decline of living standards.

Stern Review with benefit of hindsight

What did the Stern Review miss, or over- or under-emphasise?

Fully vindicated on:

Charge of alarmism – risks underestimated.

Discounting – attacks were based on ignorance or ignoring of
(a) underlying concepts,
(b) ethics,
(c) modern public economics of imperfect economies.

Role of biodiversity, natural capital: Our natural infrastructure is deteriorating rapidly, interwoven with climate change

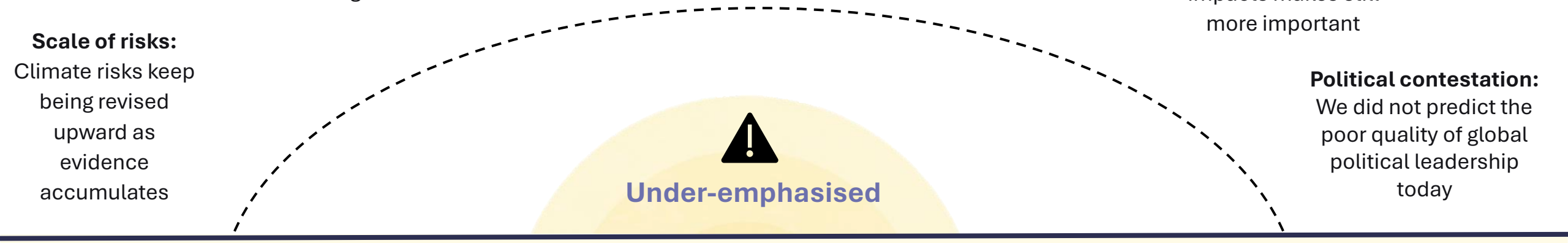
Required ambition in risk reduction: Now net-zero by 2050 rather than 80% reduction 1990-2050

Systemic and structural change: Relative to standard aggregate growth models

Pace of change of technology: Tech advancement and cost reduction have been extraordinarily rapid, often exceeding expectations

Adaptation: Was prominent in Stern Review but delayed action and intensification of impacts makes still more important

Scale of risks: Climate risks keep being revised upward as evidence accumulates



Political contestation: We did not predict the poor quality of global political leadership today

The future of analyses and action; Stern 2.0 and "The Growth Story of the 21st Century" (LSE Press, 2025, open access).
The dynamics: (1) Crucial to broader and deepen awareness of immense risks of tipping points, instability, and downstream spiral.
(2) Understand, analyse, communicate, and pursue the new growth story: sustainable and resilient growth.

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Towards clean energy: secure, cheap, widespread

High-carbon technology

Dirty: damaging and dangerous

Geographically concentrated

Many countries depend on imported fossil fuels that come through vulnerable chokepoints

Volatility and conflict

Low-carbon technology

Local energy that is cleaner and cheaper than fossil fuels.

The pace of technological **advancement and cost reduction in key new technologies** has been extraordinarily rapid, often far exceeding expectations.

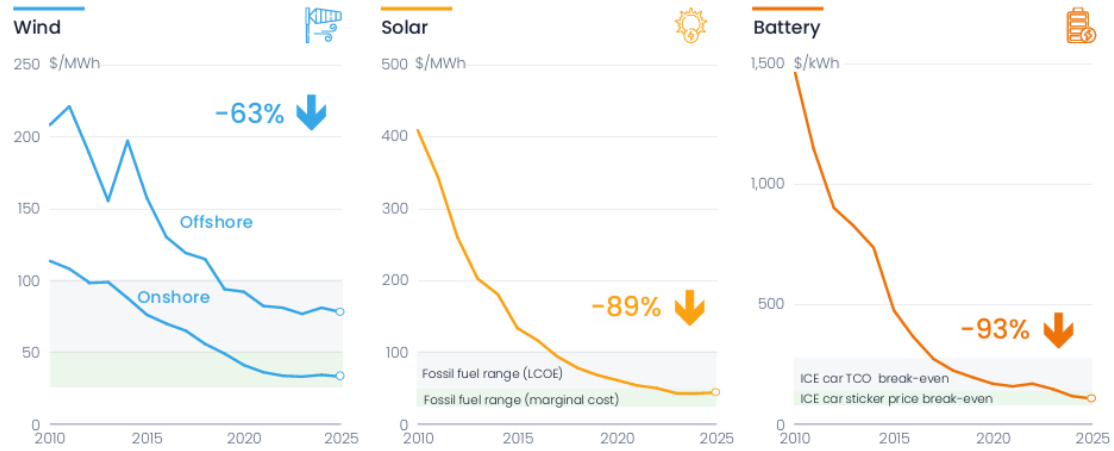
Widespread availability. 92% of countries have 10x as much renewable energy potential as energy demand (Ember, 2025).

Enhanced energy security. World markets for fossil fuels are volatile. Solar and wind are available and free as inputs. Need upfront capital to generate; investment in grids and storage for integration and reliability.

Diversification and competition in mineral extraction and processing are important for security and innovation.

Renewable power technologies: decreases in the levelised cost of electricity

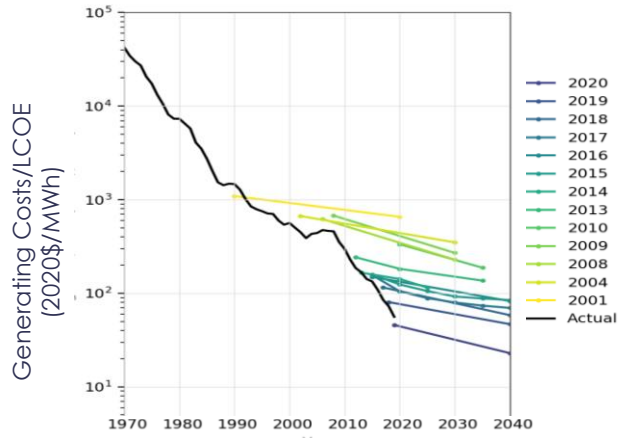
Note: Global averages for new installations. Source: Ember, 2026.



Globally, solar electricity is now, on average, 40 USD/MWh, and the **cheapest form of power in many countries**. India and China have costs of around 30 USD/MWh (IRENA, 2025).

Actual vs IEA projected LCOE of solar PV

Source: Ives et al (2021)



KEY COST REDUCTION DRIVERS

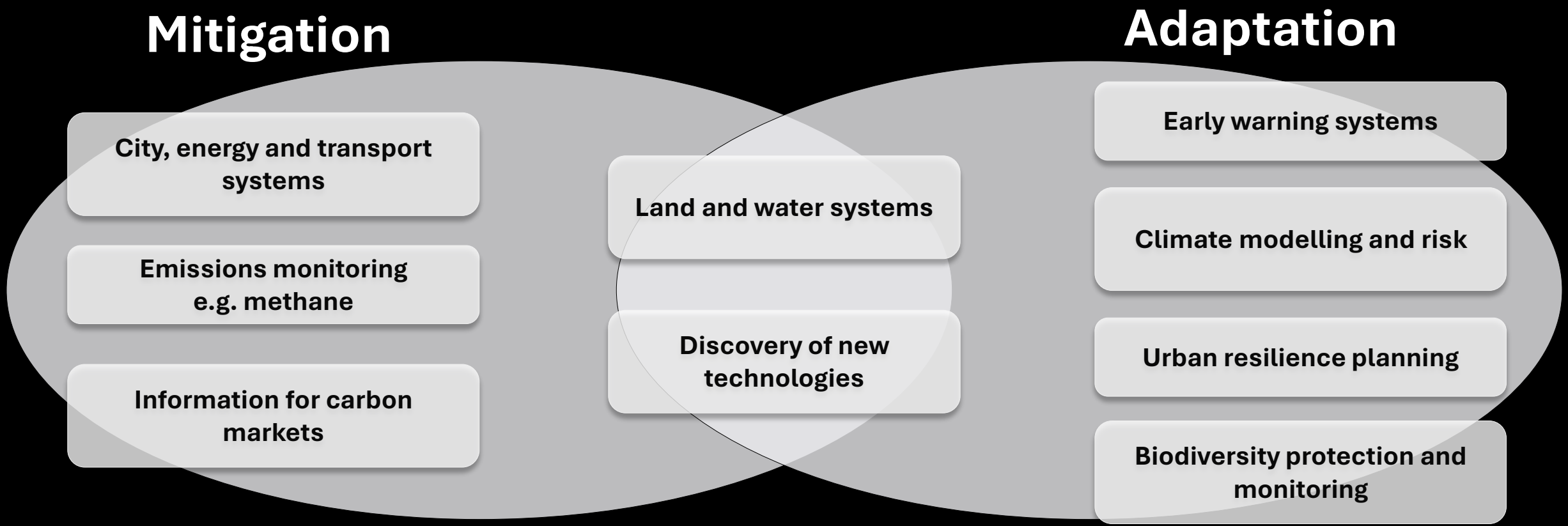
Learning-by-doing (a)

Economies of scale (b)

(c) R&D and innovation

AI and ICT: enabling smart growth for the century ahead

Accelerating powerfully into 2030s. They can bring pace, innovation and efficiency to the transition: changing and managing complex systems (cities, energy, transport, land, water), enhancing green technology, accelerating positive technological tipping points and the discovery, development, and deployment of breakthrough technologies in key sectors (fusion, quantum chemistry, alternative protein design, materials…). Crucial for adaptation.



AI must be put to work on green and intelligent growth.

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The next 25 years are critical to the next century

The challenge is to both change the nature of investment and to increase it. If we fail to do this quickly, then growth and development will likely be halted, reversed or undermined as a result of the hostile environment created.

Likely global growth and change in the next decades: three doublings

2026

It is in the developing world where the majority of world growth will occur, and where most of the infrastructure and other investments will be made in the coming two decades.

2050

>2x



Urban Population

Urban population will more than double by 2050, at which point 7/10 people will live in cities.

2050/60

2x



GDP

Growth of approximately 3% per annum. Led by emerging and developing countries.

2060

2x



Global building stock

Strong growth in EMDCs through income levels with strong demand for infrastructure.

At the same time need

- CO2 emissions
- Adaptation and resilience

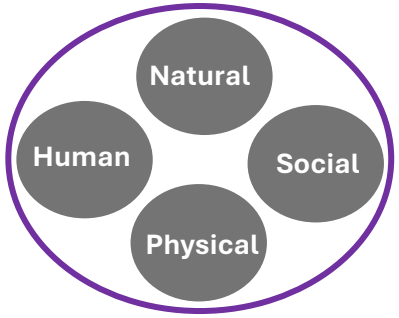
Even in a middle-income country like India the majority of the urban **infrastructure** likely to exist in 2047 will be built between now and then (Kouamé, 2024).

Because much of EMDCs' infrastructure has yet to be built, many can **leapfrog** straight to cleaner, more efficient technologies and structures.

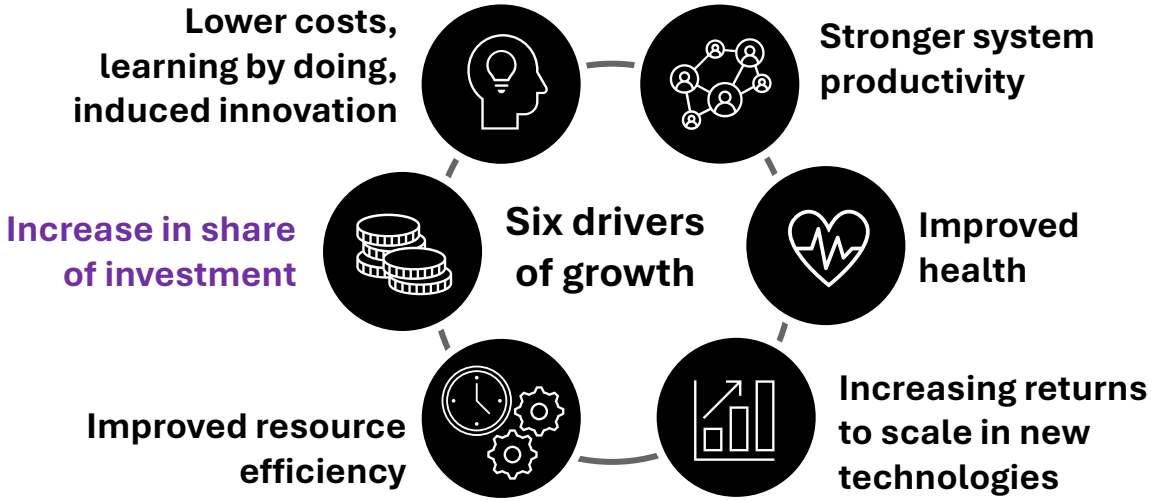
The growth story of the 21st century

There is no inevitable 'trade-off' between climate action and growth. On the contrary, the necessary investment drives a new, very different and more attractive form of growth, particularly in combination with AI.

Investment is the only one of these 6 drivers which comes into standard macroeconomic modelling. Thus, such modelling leaves out most of what is interesting and important.



Sustainability requires investment in all four capitals: physical, human, natural, social.



This is a dynamic story about investments, innovations, and structural and systemic change. And building resilience and natural capital.

Many investments deliver all three of development, mitigation, adaptation, including public transport, decentralised solar, strong grids.

Also, natural capital plays a key role, including mangroves, restoring degraded land, reforestation…

SHORT TERM

Investment in sustainable infrastructure and other assets can boost shorter-run demand and growth, sharpen supply and efficiency, reduce waste and pollution, promote sustainable development and reduce poverty. Building resilience has high returns, fostering and protecting growth.

MEDIUM TERM

Spur innovation, creativity and growth in the medium term, unleashing new waves of innovation and discovery.

LONG TERM

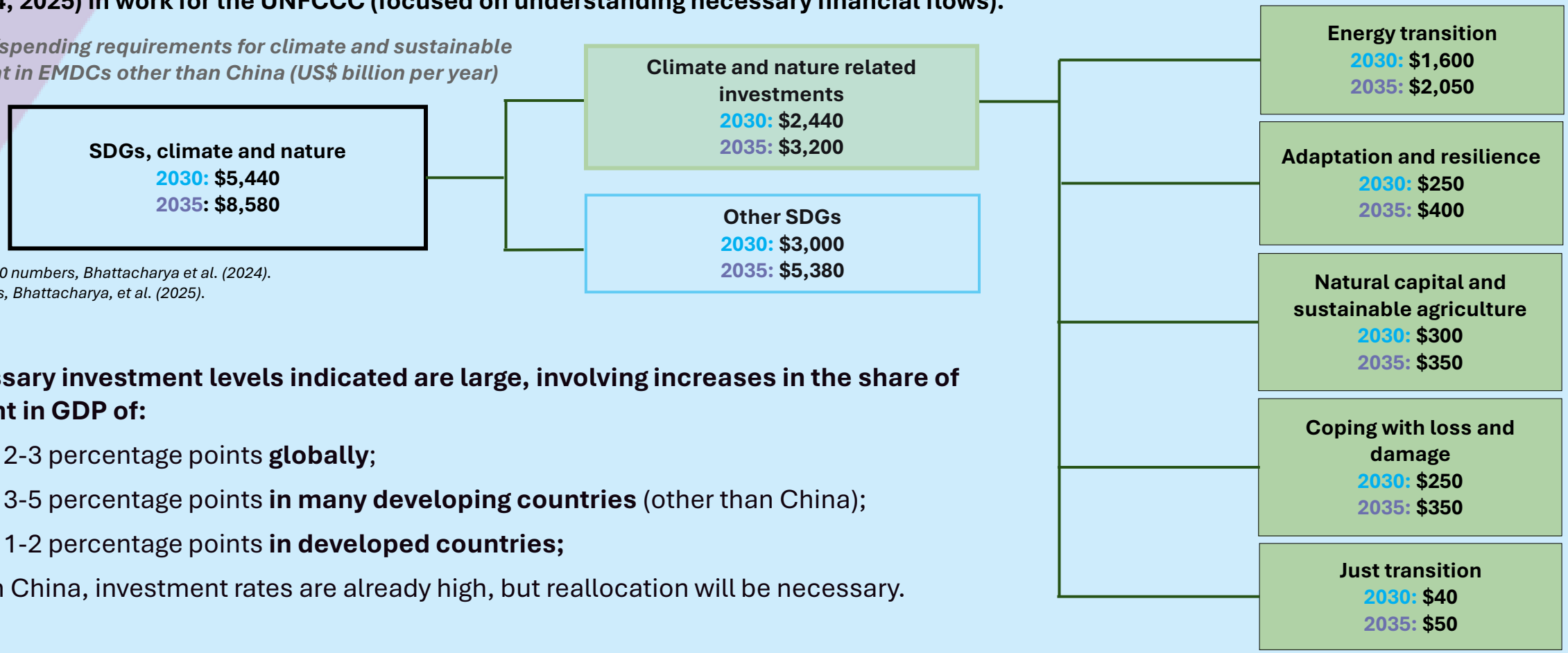
Low-carbon is the only feasible longer-run growth on offer; attempts at high-carbon growth self-destruct.

Key growth driver: a major increase in share of investment

Climate action requires substantial investment across all countries and sectors, especially in EMDCs.

The following calculations give aggregate necessary annual investment and are from Bhattacharya et al. (2024, 2025) in work for the UNFCCC (focused on understanding necessary financial flows).

Investment/spending requirements for climate and sustainable development in EMDCs other than China (US$ billion per year)



***Sources**: For 2030 numbers, Bhattacharya et al. (2024). For 2035 numbers, Bhattacharya, et al. (2025).*

The necessary investment levels indicated are large, involving increases in the share of investment in GDP of:

- ~ 2-3 percentage points **globally**;
- ~ 3-5 percentage points **in many developing countries** (other than China);
- ~ 1-2 percentage points **in developed countries;**
- in China, investment rates are already high, but reallocation will be necessary.

The bulk of the" climate and nature investments" are in infrastructure, with high returns, in addition to climate benefits. All part of sustainable and resilient growth.

Making it happen: sustainable development investment and finance

Climate action requires substantial investment across all countries and sectors. These investments are not just about meeting climate targets – they are fundamental to economic development and progress on the SDGs, within which the Paris Agreement objectives are embedded.

(1) Energy transition

Clean energy plays a vital role in economic development.

E.g. Africa holds 60% of the best solar resources in the world (IEA, 2022) but 40% of its population lacks electricity access (IEA, 2023).

(2) Adaptation and resilience

Development requires adaptation in a changing world.

E.g. Enhancing energy and irrigation systems or improving thermal insulation of buildings. High returns to adaptation investment (GCA, 2019, WRI, 2025).

(3) Natural capital and sustainable agriculture

Natural capital avoids losses that obstruct development.

E.g. Mangrove forests provide more than US$80 billion annually in avoided losses from coastal flooding (GCA, 2019).

(4) Coping with loss and damage

Climate hazards impede development through many losses and increased debt.

E.g. LDCs have faced climate-related disasters where damages reached up to 30% of GDP (WMO, 2023).

(5) Just transition

A just transition is about ensuring sustainable development is inclusive.

There is a collective responsibility to manage this transition in an equitable and just manner. Without justice, transition may be blocked.

Clean energy investments already gained momentum. According to the International Energy Agency (IEA), for 'every USD 1 spent on fossil fuels, USD 1.7 is now spent on clean energy. [In 2018], this ratio was 1:1' (2023b, p. 12). In 2025, this ratio is expected to reach 2:1 (IEA, 2025).

EMDCs are attracting more clean investment. Though high-income countries and China continue to play a dominant role in energy investment, **emerging markets attracted more than double the total new renewables investment in 2023 compared to 2018**, and 85% of low- and middle-income economies deployed more renewable energy capacity relative to fossil fuels in 2023 (Cuming, 2024).

Building resilience to a changing climate raises output and productivity, relative to not. Strengthening energy and irrigation systems, adapting farming techniques to shifting seasons and rainfall, and climate-proofing infrastructure **are good development.**

Adaptation investment yields powerful economic returns. **Every US$1 invested in resilience can generate up to US$10 in net economic benefits** – not only from avoided losses, but a "triple dividend", also including economic gains such as productivity and innovation, and social and environmental benefits (GCA, 2019)

Our economies are deeply intertwined with biodiversity, ecosystems, and the broader biome. **As we learn to invest in these critical structures, we are likely to see investments in new geographical areas across the world** (Bromley, 2024); that will be a crucial element of the 'new economic geography' (Stern, 2025).

'Restoring degraded forests generates an estimated $7–30 in economic benefits for every dollar invested.' (WRI, 2017, p.4).

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Strong barriers in society and politics

There are many sources of opposition impeding action, or indeed vigorously opposing it.
There is much political anger:



Leading to, e.g., Brexit, the election of populist leaders, ...

Making the new growth story both a narrative and reality can help overcome these problems and perceptions.

And is thus a political imperative given the dangers of populism (and climate change). It can help overcome the sense of deprivation. It can show the advantages of international collaboration and of domestic cohesion.

We must stop seeing "climate investment" as something separate from sustainable and resilient investment.

MUST KEEP ETHICAL DISCUSSION TO THE FORE: CLIMATE CHANGE DAMAGES RIGHTS TO DEVELOPMENT AND FREEDOMS FOR THIS AND FUTURE GENERATIONS (Stern, 2026, Tanner Lectures on Moral Values).

Recognise climate as an economic and security issue, not just as an environmental one. "The Growth Story of the 21st Century: the Economics and Opportunity of Climate Action" (Stern, LSE Press, 2025).

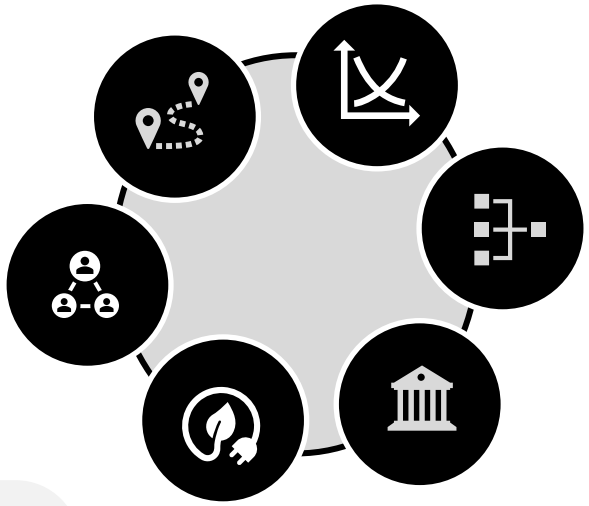
Enhanced role of the state

National strategy and direction

- **Political support** requires a compelling national vision and narrative
- Present climate policy for what it is: **action to advance well-being and development**
- Essential to show **tangible benefits** of change early
- Tackle **misinformation**

Public discussion, social buy-in, and workforce adaptation

- **Risks from structural change, including dislocation,** must be managed
- Importance of investing in **people and places**
- **Public discussion** and shared understanding are crucial to political and social 'buy-in'
- We must **learn along the way**; political systems must be open and receptive to public input



Industrial policy for a dynamic and green private sector

- **Tailored industrial policies** are needed to nurture a green private sector
- Access to the right **scale and quality of finance** must be enabled for firms and households
- **Public investment** (e.g. in key infrastructure) can facilitate private investment

International industrial policy through coalitions of the willing (see next slide)

Comprehensive management of market failures

- Carbon pricing critical but insufficient. **Multiple market failures must be tackled together** to reframe incentives and to reduce obstacles, thus fostering sound investment flows
- Examples of **other key market failures**: R and D; capital markets; networks/systems; information; "co-benefits", such as reducing air pollution

Recasting key systems: cities, energy, transport, land, water

- **Integrated investment programmes** such as for city transport or power grids
- **Use of AI** for recasting, managing, and measuring
- **Reform** of toxic subsidies and policies in land and water

Institutional strength, governance, and the investment environment

- Building **confidence in direction of change** requires policy predictability, coherence, and clear direction
- **Country platforms** can help in coordinating finance mobilisation; **standards / regulations** can guide investment across markets
- **Good macroeconomic management** is necessary alongside purposive fiscal expansion

Renewed international collaboration

The geopolitics of low-carbon transition, adaptation, and development is of core importance

Multilateral

Through international collaboration, transitions can be accelerated, costs reduced, competition and innovation fostered, and robust supply chains built. Investments in one region bring benefits across the world both in reducing climate risk and in driving sustainable growth. Centrality of the multilateral institutions, especially MDBs; they must embrace the agenda of a liveable planet and be "bigger, bolder, better" – see reports by International Expert Group chaired by NK Singh and Larry Summers for the India G20 Presidency, 2023.

Duty of rich countries to both cut emissions quickly and support EMDCs in fostering and financing investment given that past emissions have made development more difficult. And it is in rich country self-interest: they can drive their own growth, improve their climate, and reduce future migrations.

Plurilateral

Sometimes it is possible to get nearly everybody together, but other times it is important to focus on the willing; the plurilateral.

"to help solve global problems…it's building coalitions that work, issue by issue, with partners who share enough common ground to act together." *PM Mark Carney, Davos, 2026*

Key action areas for coalitions of the willing: supply chains; technologies; AI for climate; adaptation; movement away from fossil fuels; methane; cities; agriculture; water; forests; oceans; carbon pricing; IFIs… **Coalitions can be advanced at COPs.**



Source: WEF (2026)

Europe can work more closely with **India and China**, including on technology.
China dominant in most clean technology. Tension: its dominance can create friction in the West. Collaborate elsewhere, particularly in Africa. India is advancing towards being a key manufacturer/market.

Unanimity around COP statements not necessary for implementation.

Looking ahead: three key ideas and trends shaping the century ahead

Narrative: Climate action drives economic growth and builds economic security

Climate is not just an environmental issue.

It is a national economic and security issue.

It is about avoiding risk, enabling development, creating a better, more equitable, resilient, and sustainable world.



Growth leaders: EMDCs

EMDCs largely shape the future: population, urbanisation, clean energy, critical minerals…

Developed countries' share of global output (PPP) fell from ~65% (1980) to ~40% (2024) – with China constituting ~20% and EMDCs (other than China) ~40% (IMF, 2024).

New partnerships, collaboration, needed. Coalitions of the willing.



Challenge: In politics and society

To generate and sustain support for change, economic policy must bring **benefits quickly**.

Policy must be designed to account for and **reconcile different interests**. Implementation is complex and messy.

Political leadership is crucial.



The new growth story: Imperative and opportunity

- The core conclusion of the Stern Review, that the cost of inaction far exceeds the cost of action, has stood the test of time, indeed has become still stronger.

- Delay has intensified necessary urgency and scale of action. The next two decades are crucial:

(i) When so much of the infrastructure of EMDEs will be built; (ii) when climate change moves into great risk, potentially reaching 2°C and encountering tipping points.

- Paris target of well below 2°C is still possible, but we will pass 1.5°C. Limit overshoot and plan for return.

- The new growth story is a huge opportunity. It requires strong investment and innovation, mostly private, and rapid systemic structural change. Active public policy and action will be critical to foster change at the pace and scale needed.

- I remain optimistic about what we can do but worry about what we will do. We can, but will be?

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