



Grantham Research Institute on Climate Change and the Environment
public lecture

Growth and Sustainability: 10 years on from the Stern Review

Professor Lord Stern

Chair, Grantham Research Institute on Climate Change and the Environment
President, British Academy

Professor Simon Dietz

Chair, LSE

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Growth and Sustainability: 10 years on from the Stern Review

Nicholas Stern

Chair of the ESRC Centre for Climate Change Economics and Policy

Chair of the Grantham Research Institute on Climate Change and the Environment

IG Patel Professor of Economics & Government, London School of Economics and Political Science

President of the British Academy

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Structure

- **Part 1: History and key messages of the Stern Review**
- Part 2: Understanding the issues, changing perspectives
- Part 3: Beginnings of action
- Part 4: Modelling and the ethics of climate change
- Part 5: Global collaboration and taking the opportunity

A brief history

- **Four decades prior to the Stern Review working on public policy and economic development. Work included:**
 - Theories of optimum growth and taxation (1968 onward)
 - Smallholder tea in Kenya (1969)
 - Studying a village in India, Palanpur (1974 to date)
 - Tax policy in India and the UK (1981 onward)
 - Report for the Commission for Africa, which was published ahead of the G8 summit in Gleneagles in July 2005.
 - Chief Economist of the EBRD and World Bank.
- **Commissioned, whilst head of GES, UK to write the Stern Review by Chancellor of Exchequer and Prime Minister in 2005.**
 - Launched on 31 October 2006 at the Royal Society in London.
 - Published by Cambridge University Press in January 2007.

Contents of the Review

- The Review was of the “Economics of Climate Change” (6 parts, 27 chapters, 700 pages). Focus on understanding risks and on policy.
 - Science; economics; ethics,
 - Impacts and modelling potential damages,
 - Policy responses including prices, taxes and regulations for mitigation,
 - Costs/investments for mitigation; structural change; technical progress,
 - Policy responses for adaptation in developed and developing world,
 - Collaboration and international action.

Key messages of the Stern Review

- **All countries will be affected by climate change**, the poorest countries will suffer the earliest and most severely. Potential scale of damage is very large.
- “The costs of action” **are far less than** “the costs of inaction”.
- **Delay in action is dangerous.**
- Climate change is the **greatest market failure** the world has ever seen.
- Well designed **policy can deliver strong results.**
- **Global collaboration** and action required.

These messages have stood the test of time; indeed have become still stronger.

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The science is still clearer...

- The science is robust. Built on **two centuries of theory and evidence**. The evidence grows ever stronger that risks are immense and still larger than previously thought.
- **Current emissions at 50 GtCO₂e (around 41 GtCO₂e in 2005)**. Still on an upward trend.
- Many of the effects coming through **more rapidly than thought** (loss of ice sheets, glaciers etc.). 15 of the 16 warmest years on record have now occurred since 2001, 2016 predicted to be warmest year on record (NASA, 2016).
- CO₂e concentrations rising rapidly, now around **450ppm** of CO₂e
 - Adding CO₂e at a rate of over 2.5ppm per year (likely to accelerate with little or weak action). This is up from 0.5ppm per year 1930-1950, 1ppm 1950-1970 and 2ppm 1970-1990.
- Inaction or weak action could take us to **over 850ppm CO₂e** over a century: strong possibility of eventual temperature increase of more than 4°C or 5°C (increase in global average surface temperature above second half of the 19th century).

The risks are unprecedented for humankind

- Potential damage from climate change **intensifies as the world gets warmer**:
 - Already near 1°C, edge of the experience of the stable period during the Holocene (last 10,000 years) where civilisation developed (cereals, villages, surpluses...).
 - Seeing strong effects now; yet small relative to what we risk.
 - **Serious risks of tipping points** and potential irreversibility if we go beyond 1.5 °C (loss of sea ice, land ice melt, sea level rise, change in ocean current circulation, thawing of permafrost, die-back of the Amazon and other tropical rainforests). Still higher risks beyond 2 °C.
 - Temperature increase of **4 or 5°C** or more not seen for **tens of millions of years** (homo sapiens, 250,000 years):
 - Likely be enormously destructive.
 - The reasons we live where we do would be redrawn (e.g. too much or too little water).
 - Potentially causing severe and sustained conflict with migration of hundreds of millions, perhaps billions of people.
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Delay is dangerous

- **Uncertainty and ‘publicness’ of the causes of climate change might suggest delay to learn more. That would be a profound mistake.**
 - The “**ratchet effect**” from flows of GHGs to concentrations (CO₂ hard to remove).
 - “**Lock-in**” of long-lived high-carbon capital/infrastructure involves either commitment to high emissions or early scrapping of capital/infrastructure.
 - Rapid urbanisation and building of infrastructure.
- The later the action, the smaller the likelihood of holding to 2°C and the more costly to achieve it.
- Delay also increases reliance on unproven future technologies (e.g. negative emissions) or more ambitious action in future (politically feasible?).

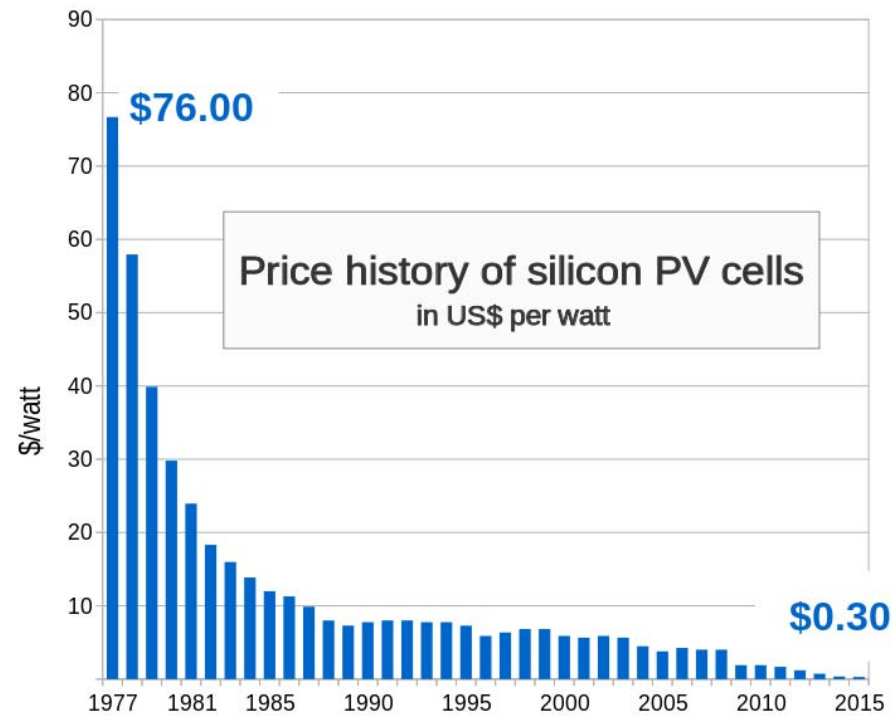
What to do to hold warming below 2°C

- Can do a little more earlier and a little less later and vice versa but shape of feasible paths similar.
- Stabilising temperatures **requires stabilising concentrations, which will require net zero emissions**. The lower the target temperature, the earlier the necessary achievement of net-zero.
- **Paths to achieve under 2°C likely to require:**
 - **zero total emissions** well before the end of century.
 - **Net negative emissions in major sectors** well before end of century (because some sectors likely to be positive).
- Total current Paris pledges (INDCs) are for emissions of around 55-60 GtCO₂e per annum in 2030. Whilst improvement on BAU (ca. 65-68 GtCO₂e per annum), need to be around **40 GtCO₂e or less per annum by 2030**.

The “costs of action” and investing in growth

- With hindsight Stern Review underestimated the risks and costs of inaction.
- The notion of “costs of action” is being **transformed by rapid technological advances**:
 - Efficiency, demand management; renewable energy (solar, wind) and energy storage technology.
 - Continuing rapid technical progress in digital, materials, bio-tech....
- Better **understanding of dynamics of change** and leaning; and of the consequences of dirty infrastructure (e.g. air pollution from burning fossil fuels).
- No longer a story of simple-minded trade-offs as embodied in the United Nations Framework Convention on Climate Change (1992). Action is now seen as the growth story of the future.
 - Shift from a focus on the “**costs**” to one of “**investment**”.

There is a continued fall in technology costs



Source: Bloomberg New Energy Finance & pv.energytrend.com

Growth story of the future

- Recognition that **growth, sustainable development, poverty reduction and climate change** are complementary and interwoven. “Better Growth, Better Climate” (NCE, 2014); (“Why are we Waiting?” MIT Press, Stern, 2015) (“Delivering on Sustainable Infrastructure for Better Development and Better Climate”; Bhattacharya, A., Meltzer, J., Oppenheim, J., Qureshi, M.Z. and Stern, N, 2016)
 - **Opportunity to:**
 - Boost shorter-run growth from increased investment in the low-carbon transition (sustainable infrastructure);
 - Spur innovation, creativity and growth in medium term;
 - Offers the only feasible longer-run growth on offer.
 - A growth story that delivers: **alternative paths of economic development; rising living standards, cities where we can move and breathe; stronger communities; ecosystems that are more productive and resilient.**
 - Action has to occur across whole economy; **focus on cities, energy and land.**
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Progress in nations, cities and regions has been slow, but momentum is building

- Already, about **40 national jurisdictions and over 20 cities, states, and regions** are putting a price on carbon.
 - More are in the pipeline: China National ETS (2017), South Africa (2017), Chile (2017), Canada (2018),...
- **Development Banks are supporting low-carbon investment:**
 - Climate change and sustainable infrastructure is now a priority for regional development banks, World Bank and IMF; also FSB. Both growth and stability.
 - NDB (new “BRICS” bank) financing entirely RE projects with first funding round,
 - AIIB “a clean and green” bank,
 - Establishment and capitalisation of the GCF. Now beginning to distribute.
- **Importance of policy credibility in generating investment:**
 - **Commitment to further climate action** from some of the worlds largest emitters: China (13th Five-year plan), EU (2030 climate & energy framework), USA (Clean Power Plan).
 - By the end of 2014, there were **804 climate change laws and policies** amongst 99 countries, compared to 426 in 2009.

Cities are also pursuing strong ambitions

- **Cities are now looking to address climate change to reduce air pollution and environmental degradation**; make cities more attractive, liveable, convenient; enhance energy and resource security, develop new growth industries in clean sectors, and build resilience.
- Contributions so far include:
 - **7,100 cities from 119 countries** have committed to the *Compact of Mayors for Climate & Energy*. Pledged to support meeting national targets, e.g. EU signatories have pledged to reduce CO₂ emissions by at least 40% by 2030 compared to 1990.
 - Increasing **recognition of the role of ecosystems services and infrastructure** for resilience and public services (1,069 cities are signatories to the Durban Adaptation Charter by the end of 2015)
 - **Expansion of electric vehicles** and public transport (NYC planning to have largest municipal EV fleet in the US).
 - **Support for renewable energy and energy efficiency** in buildings and heating (e.g. Oslo aiming to phase out fossil fuel heating in homes and offices by 2020).

Action is being taken by some private sector firms and investors

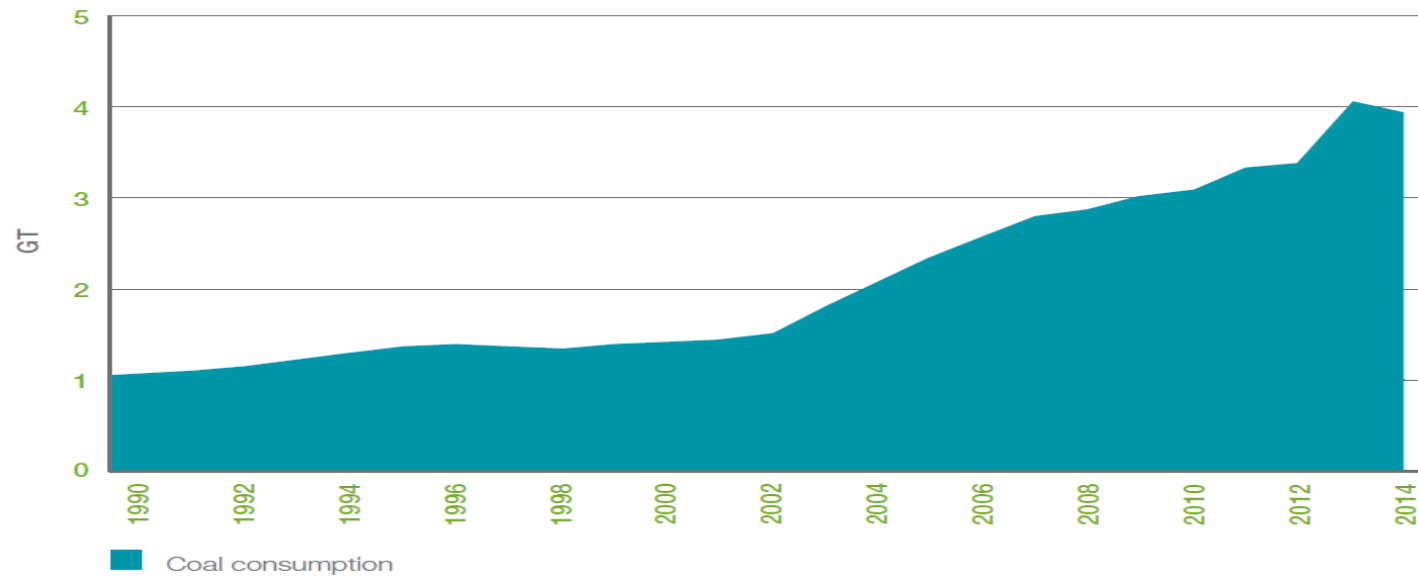
- Increasing **momentum from private sector actors** and investors around climate change and sustainability:
 - Swedish National Pension Fund (AP4) has made the **biggest low-carbon commitment of any institutional investor to date**, US\$3.2 billion in passive investment funds designed by MSCI. Intend to decarbonise \$14.7bn global equity portfolio by 2020.
 - PKA, Denmark's fourth-largest pension fund, with €35.5bn in assets, has asked 53 companies that generate between 25 - 50% of their revenues from coal to provide plans on how they will reduce their exposure to the fossil fuel.
 - **IKEA** has pledged **€1bn on renewable energy** and climate change efforts.
 - **Unilever aims to be 'carbon positive'** in its operations by 2030, committed to sourcing 100% of total energy across its operations from renewables by 2030,
- **Many firms are also implementing internal carbon prices to guide decision making.**
 - Around 430 companies are pricing carbon internally, including Disney (US\$10 -20 per tCO₂), WPP (US\$29 per tCO₂), some oil and gas majors (ranging from US\$ 40 to US\$ 80 per tCO₂)

Progress in the UK

- UK has played a critical leadership role on climate change:
 - through domestic action (passage of landmark Climate Change Act in 2008),
 - its climate diplomacy (leading and respected voice in the EU and international negotiations); and
 - its investments through aid in low-carbon and climate-resilient economic growth and development in poor countries.
 - The UK has demonstrated that growth and emissions reductions can be achieved together:
 - UK's economy has grown by more than 60% since 1990 while reducing annual GHG emissions by 38%.
 - Passage of **Climate Change Act in 2008** has created a model of framework legislation for other countries.
 - Continues to lead through announcing ambitious targets and policies, (e.g. end to coal power by 2025)
 - Worrying abrupt adjustments in policies last year raise question marks.
-

China and structural change

- China (13th Five-year plan) makes **climate change and the environment a central theme**, and sets out their commitment.
- It is estimated that coal consumption in **China has reached a structural maximum** and will start declining in 2020.



Total Coal Consumption in China (1990 – 2014)

Source: Green and Stern, 2015

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Analytical approach of Stern Review

- 27 chapters looking at macro, micro and international issues in detail. Just two on growth modelling (ch.2 and 6). Cautioned against attaching excessive weight to long-run growth modelling in context where structures potentially subject to great disruptions. Nevertheless do throw some light on some issues.
- No analytical errors of substance in 700 pages (a few typos).
- Some perspectives challenged, particularly on scale of damages and risks. But, if anything, review underestimated damages and risks. Target concentrations and temperatures should be tighter than suggested.
- On discounting, much discussion showed worrying ignorance of basic concepts and principles including suggestions that could “read off” discount rates from markets. See below.
- Many, including Bill Nordhaus, have moved in direction of conclusions of the Review.

Problems with many IAMs

- Much of early contribution of economics to climate change has attempted to analyse cost and benefits of action; primarily through the use of Integrated Assessment Models (IAMs).
 - IAMs try to combine modelling of emissions and climate systems with analysis of growth damage and risk. **They suffer from a poor evidence base** (e.g. Pindyck, 2013). World has not seen 3+°C for millions of years.
 - They are seriously deficient in their modelling of the **nature and scale of risks and damage**.
 - Most of the modelling of damages simply relates GDP loss to **current temperature** changes (e.g. ignores damages to capital stocks or growth rates)
 - They are calibrated to **absurdly low damage levels** (e.g. only a 50% loss of GDP from 18°C increase). Stronger “convexity” in shape of damages curve radically changes the cost estimates (Dietz and Stern, 2015)
 - Embody very low risks. Higher risks radically change the perspective (Weitzman, 2012).
 - They overestimate the cost of action
 - Little or no learning or economies of scale from action
 - **Fail to value satisfactorily the very large co-benefits** that are possible from a low-carbon transition (e.g. reduced air pollution or stronger ecosystems).
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Dangers of “shoe-horning” climate issues into “familiar” models

- Climate risk in its scale and nature is **very different from marginal or modest perturbations** to an underlying model of growth.
- Potential submergence of large areas, desertification of others, potential intensification of severe weather events, movement of people on a large scale, potential sustained and widespread conflict. **Not consistent with long-run story given underlying growth rate or economic structure.**
- **On the policy side, marginal models miss the dynamic public economics of systemic change.**
 - Marginal abatement cost (MAC) models ignore the inherently systemic nature of transformative change. **Policy action involves a very different approach to growth, infrastructure, cities.**
 - They fail to model benefits of learning, innovation and impacts on future prices or technology options.

The ethics of climate change: must face explicitly

- Challenge gives rise to fundamental normative questions that economics cannot avoid addressing, including the need to think about immense damages, conflict, loss of life in the future, possible reversal of development, profound distributional change, justice and rights.
- All major approaches to moral philosophy (Kantian, contractarian, Aristotelian (virtue), justice, rights, pluralism...) seem to point in same general direction: **strong action to reduce emissions is morally required. (WAWW, Chapter 6)**
- **Intergenerational ethics: *How can we compare the value of goods and lives today vs in the future?***
 - Ethics discourse in economics has focused heavily on intergenerational equity (discounting).
- **Intra – generational ethics: *distribution of damages and which countries should do what and when?***
 - **Double inequity** – rich countries major responsibility for past emissions. Poor people hit earliest and hardest; also within countries.
 - Arithmetic implies **faster cuts for rich countries**. With more than a billion people in mid-century a 2°C path will require average per capita emissions around 2 tonnes CO₂ p.a. If few people below there can only be a few above.

How we manage the ethics – the issue of discounting

- Discounting is the process of adjusting the value attached to a unit of some good accruing in the future to compare with the value of a unit of that good if available today.
- That relative value is the discount factor (and its proportional rate of fall is the discount rate) will usually vary across time, good and person. Depends on future development of the economy and on the good chosen for accounting. **Future generations maybe much worse off with badly managed climate change**, thus could place higher weight (involving negative discount rates) on extra good at that time.
- Some argue that relevant discount rates can be ‘read-off’ from market interest rates or rates of return. This is a mistake: **markets do not reflect ethical decisions**; capital markets over long term are full of imperfections; discounting depends on future living standards (highly endogenous and difficult to predict).
- **Pure-time discounting** of future welfare or lives places lower weight on a future life which is otherwise identical in all relevant circumstances. This is **discrimination by date of birth**. Very hard to provide any ethical justification.
- **Risk and uncertainty best treated explicitly** (e.g. via expectations of social welfare or avoidance of catastrophic outcomes rather than “rolling into” discount rates.

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Outstanding progress internationally in 2015/2016: a new global agenda

- 2015 and 2016 **breakthrough years for global collaboration** around climate change and development.
 - The global agenda for action has been set with agreements on:
 - Financing for development in Addis (July 2015)
 - Sustainable Development Goals (Sep 2015)
 - Paris Agreement on Climate Change (CoP 21) (agreed Dec 2015, enter into force in Nov 2016; very rapid ratification)
 - Kigali Amendment to the Montreal Protocol on HFCs (Oct 2016)
 - New Urban Agenda (Oct 2016)
 - Was slower than hoped (e.g. from Copenhagen in 2009), **but now strong**.
 - **First shared global agenda since agreements after WW II.**
-

The Paris Agreement (1)

- Target “well below 2°C” and “pursue efforts” for 1.5°C.
- Total planned 2030 emissions around 55 Gt CO₂e p.a. or more. Thus 10% increase as opposed to at least 20% reduction (to 40 Gt) for paths consistent with 2°C.
- Recognition of gap and thus agreement to attempt every 5 years to ramp-up ambition. Text on measurement forests, finance etc.
- Processes are “binding”; not the numbers.
- Side initiatives on innovation including: Mission Innovation; International Solar Energy Alliance; Breakthrough Energy Coalition.

The Paris Agreement (2)

- Paris Agreement on Climate Change was a **remarkable achievement** after years of debate and fundamental disagreements; **signed by 175 countries at UN on 22 April 2016** (most in history on single day).
- On 5 October 2016, the double threshold of 55 countries and 55% of global emissions was passed, meaning that the Paris Agreement will **enter into force on 4 November 2016**.
- Foundation of agreement was built on the understanding of:
 - the **scale of risks and urgency to act**, and
 - **attractiveness of alternative path** as sustainable route to lasting development and overcoming poverty.
 - USA – China, mutual understanding on the need for action played crucial role.
- Compare to Bretton Woods: 44 countries (1 dominant); previous 30 years had 2 world wars and great depression.
- Paris Agreement was based on anticipation of great risk rather than grim experience (Bretton Woods).

SDGs and Development

- **Broad commitment to the Sustainable Development Goals (SDGs) was achieved last September (to replace the MDGs); responsibility of all countries to meet them.**
 - Of the **17 SDGs** agreed, **12 explicitly mention climate change**, environment or sustainability. Is implicit in the remainder.
- **Financing for development in Addis (July 2015) reached agreement on the *Addis Action Agenda* to support meeting SDGs. Outcomes included:**
 - An economic framework to support the sustainable development agenda.
 - Reached an agreement to increase finance for development from “**billions to trillions**”.
 - Calls for an elevated effort for infrastructure investment, and
 - Supports strengthening the roles of DFIs, MDBs and their role in development.
- **Essentially a transforming of investment rather than single budget for climate finance. It is a story of sustainable infrastructure.**

Delivering on the global challenges: growth, infrastructure and sustainability

- **Three central challenges facing the world community:**
 - How to **reignite global growth**?
 - How to **deliver on the Sustainable Development Goals (SDGs)**?
 - How to **take strong action on climate change**?
- **Three forces present us with special opportunity:**
 - Historically low interest rates and search for growth offer the opportunity to finance the transition (sustainable infrastructure is key).
 - Rapid technological change offers optimism for the future (digital, materials, biotech...).
 - International agreements have provided clear political direction and evidence that collaboration is possible.

Great opportunity to embark on new, attractive and sustainable path; but dangers of “lock-in” if action delayed

- Current development **path is towards dirty infrastructure**, congested and polluted cities, destruction of forests. Creating grave danger of lock-in of high carbon infrastructure and irreversible effects.
 - **Mitigation, adaptation, development are intertwined**: agriculture, water, transport, energy, buildings, cities...
 - The direction and nature of economic development matters, and it makes sense to **integrate climate policy with development planning and investment decisions**.
 - 3.5bn people in cities now, 6.5bn in 2050; **growth led by developing world creates great opportunities** for transformational investment. But great danger of cities designed and built badly (congestion, pollution, emissions...)
 - Investment in **sustainable infrastructure is at the heart**, must average **\$5-6 trillion p.a.** over the next 20 years.
 - Around 70% will be required in developing countries.
-

Next 10 years requires strong policy and investment if we are to grasp the opportunities of the next 20 years.

- We **now collectively have to deliver** on the 21st century growth story:
 - If we fail to manage climate change, we will fail on the overcoming poverty.
 - If we manage climate change in a way that puts barriers to development, we will not have the coalition needed to overcome climate change.
- If we do not take the opportunities now, **2°C will be out of reach and we will risk reversing development gains, having cities where we cannot move or breathe, or ecosystems that collapse.** The gains are potentially great, but so too are the risks of delay.
- We have to collectively harness the momentum, increase collaboration and implement agreements. **It is about working together to incentivise, foster and finance change.**
- Are winning the arguments but action still far too slow.
- The actions of the next 20 years are decisive and are shaped by our actions and policies in the next 10 years.

We know what needs to be done, we know how to begin, and we will learn along the way.

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