The Criticality of the Next 10 Years-

Delivering the Global Agenda and Building Infrastructure for the 21st Century

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

28 October, 2015

Grantham Research Institute on Climate Change and the Environment

Centre for Climate Change Economics and Policy

E·S·R·C Economic & Social Research Council

The Grantham Foundation for the Protection of the Environment

University of Leeds

LSE The London School of Economics and Political Science

Structure

1. **Risks, the required action, the global agenda**
2. **Urgency and scale**
3. **The 21st century growth story: delivering on the global agenda**
4. **Building sustainable infrastructure**
5. **The next 10 years- prospects for the future**

Where we may be heading: concentrations and temperatures

- The science is robust. Built on **two centuries of theory and evidence.** Emissions increase concentrations of GHGs, trap more infrared radiation in atmosphere, leads to warming. **The evidence grows ever stronger that risks are immense**.

- **Current emissions at 50 $GtCO_2e$ (around 41 $GtCO_2e$ in 2005).** Still on an upward trend.

- CO_2e concentrations rising rapidly, now around **450ppm** of CO_2e.
  - Adding CO_2e 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 above **850ppm CO_2e** 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 1°C, at edge of experience of Holocene (last 10,000 years) and civilisation (cereals, villages, surpluses…).
  - Seeing strong effects now; yet small relative to what we risk.
  - Serious risks of tipping points and potential irreversibilities 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.

A new global agenda

- **The milestone events of 2015 have set a new global agenda focused on three simultaneous challenges:**

Reignite global growth- ***G20***

Deliver on the SDGs- ***UN, Sep 2015***

Drive strong climate action- ***COP21***

- **Delivering on sustainable infrastructure is at the centre of all three challenges.**
- **Well-designed infrastructure can be pro-growth, pro-poor, and pro-climate.**

Structure

1. Risks, the required action, the global agenda
2. Urgency and scale
3. The 21st century growth story: delivering on the global agenda
4. Building sustainable infrastructure
5. The next 10 years- prospects for the future

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 (CO_2 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 less 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 requires net zero emissions**. The lower the target temperature, the earlier the necessary achievement of net-zero.

- **Paths to achieve under 2ºC likely to require:**
  - **zero total net 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).

- Current Paris pledges (INDCs) are for emissions of around 55-60 $GtCO_2e$ per annum in 2030. Whilst improvement on BAU (ca. 65-68 $GtCO_2e$ per annum), need to be around **40 $GtCO_2e$ or less per annum by 2030.**

- **Holding temperature to below 2°C requires immediate action.**

Structure

1. Risks, the required action, the global agenda
2. Urgency and scale
3. The 21st century growth story: delivering on the global agenda
4. Building sustainable infrastructure
5. The next 10 years- prospects for the future

Sustainable growth requires strong investment

- If clear direction is provided, new investments can lead to:
  - **New sources of growth**, laying the foundation for long-term sustainability.
  - **More resilient, efficient, less polluted, less congested cities**.
  - More **inclusive growth**: better access to jobs with better cities, decentralised energy, etc.
  - Protection of **forests, land, ecosystems**, water sources and biodiversity.
- Important to manage constructively dislocation and costs of change.
- No shortage of savings in world. Challenge is to turn great investment opportunities into real investment projects.

Strong investment requires clear and credible direction and policies

- The urgency is still greater than we thought: great danger of lock-in to high-carbon systems as our economies develop; urbanisation in developing world.
- Spurring low-carbon, climate resilient growth requires the redirection of investment and financial flows over long periods. Act quickly but be consistent.
- The **consistency, clarity and credibility of development and climate policies** are imperative. Policy makers need to set a **clear, long-term direction of travel**. **Government-induced policy risk is the biggest deterrent to investment worldwide.**
- Be '**predictably flexible**'. Circumstances will change and there will be learning and technological advance - indeed a key objective. As these changes occur policies will need revision but approach to and criteria for revision should be clear.

Market failures go beyond the fundamental issues of damage from emissions

- **Six key market failures relating to climate change**. Different failures point to different instruments, but the collection is mutually reinforcing**:**
  - **Greenhouse gases:** carbon taxes / cap-and-trade / regulation.
  - **R,D&D** (research, development and deployment): tax breaks, feed-in tariffs (FIT) for deployment, publicly funded research.
  - **Imperfection in risk/capital markets:** risk sharing/reduction through guarantees, equity, feed-in tariffs, floors on carbon prices. FIT straddles first 3 imperfections. **Green/infrastructure development bank**: reduces policy risk, provides leverage, longer-term horizon, power of example.
  - **Networks:** electricity grids, public transport, broadband, recycling, community-based insulation schemes. Government frameworks needed.
  - **Information:** for consumers labelling and information requirements on cars, domestic appliances, products more generally; awareness of options. Similar issues for producers.
  - **Co-benefits:** valuing ecosystems and biodiversity, valuing energy security, regulation of dirty and more dangerous technologies. Pollution damages from burning fossil fuels are immense, US$ 3-4 trillion p.a. (IMF, 2015).

Working together to promote change: G20, nations, business, public

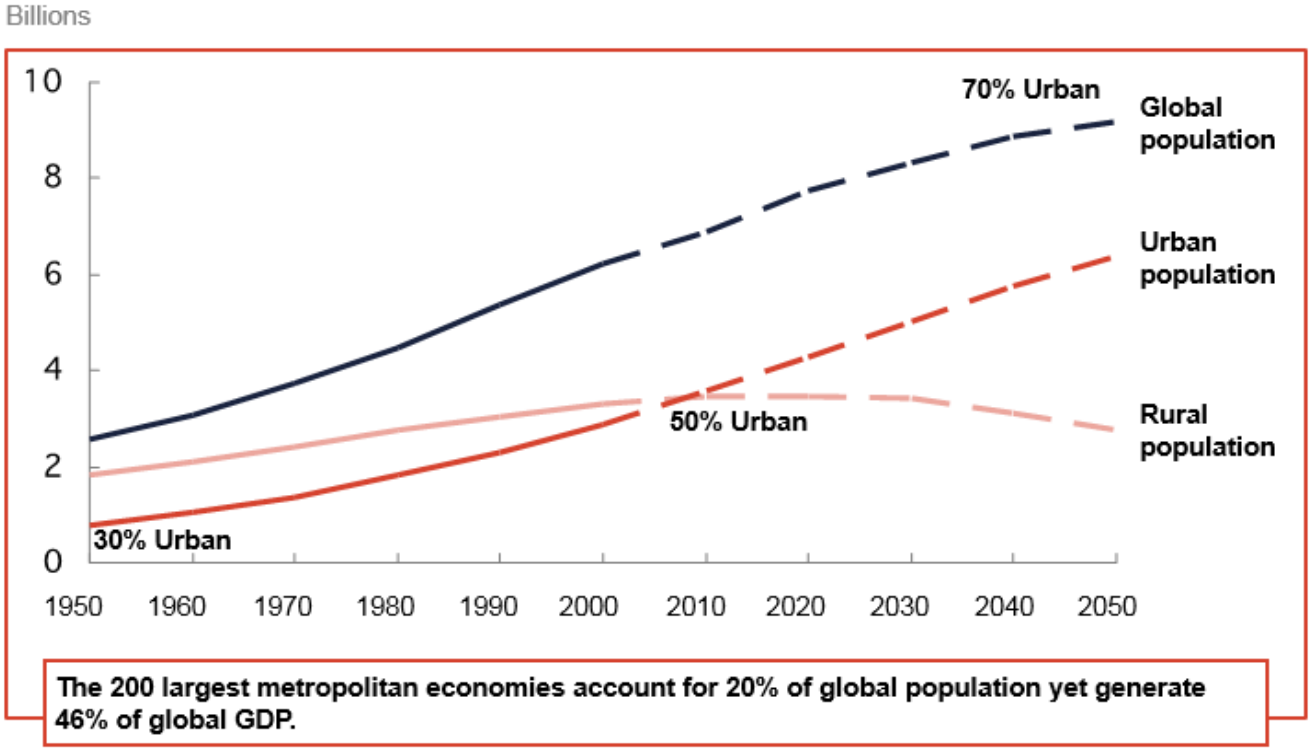
- **National authorities and G20 should clearly commit to global agenda of sustainable growth and sustainable infrastructure to create confidence that investors need in the overall policy direction.**
  - G20: leadership role in taking actions needed to foster the necessary infrastructure such as those incorporating climate risk and sustainable development factors more explicitly.
- **Business: companies should invest more strongly in R&D to drive the new "wave of innovation".**
  - Clean supply chains.
  - Internal carbon prices.
  - Energy efficiency (will be close to half of the necessary action).
  - Automobile, aircraft and shipping manufacturers can promote and ramp up production of clean vehicles.
- **Public pressure: voters and consumers.**

Institutions for prices, innovation, finance

- **Deepen global understanding of carbon pricing** (Carbon Prices Leadership Coalition).
- **Strengthen investment frameworks, institutional capacities and policies.**
  - Development banks, bilateral aid and climate finance organisations can provide information, incentives and facilities to promote clean and energy efficiency infrastructure.
    - Leverage private capital.
    - EBRD's Green Economy Transition has invested €20 billion since 2006 in 22 countries, partnering with local financial institutions to serve more than 75,000 clients.
- **Ramp up investments in clean technology development and deployment**
  - The Mission Innovation initiative (comprised of 20 countries including the US, China and the EU) has committed to doubling public investments in energy research over the next 5 years.
- **Finance: banks** (including development banks)**, regulators and wider community** (G20, OECD) **should work to mobilise lending capacities, and foster productive and profitable private capital.**
  - Must expand capacities of development banks and foster profitable and long-term capital.
  - Heed stability warnings of chair of FSB (Mark Carney) and implement and advance Bloomberg Task Force on Climate-related Financial Disclosures.

Cities as drivers of change

- **Cities are source of large majority of emissions and are growing rapidly.**
- **Cities are particularly vulnerable to climate risks: floods, droughts, heat stress,…**
- **But are well placed to benefit from strong action:**
- innovation
- increased efficiency
- reduced noise
- reduced congestion
- reduced pollution
- attractive environment for skilled labour/ entrepreneurs/ innovative firms, etc.



Source: LSE Cities based on United Nations World Urbanization Prospects, 2007 Revision

Structure

1. Risks, the required action, the global agenda
2. Urgency and scale
3. The 21st century growth story: delivering on the global agenda
4. Building sustainable infrastructure
5. The next 10 years- prospects for the future

Infrastructure is central to the story

- **Expected future emissions from *existing* power plants alone will take us over 2ºC with 50% probability (Pfeiffer et al., 2016).**
- **For Paris and SDGs, global infrastructure investment must nearly all be clean/green from now on (Pfeiffer et al., 2016).**
- **Infrastructure investment is central to Paris COP21, SDGs and spurring growth.**

Sustainable infrastructure and Sustainable Development Goals

Next 10 to 20 years are of crucial importance

- **Long-lasting infrastructure investments on scale will need to be made in our cities, energy and water systems and in transport systems.**

- **These huge anticipated investment needs for sustainable infrastructure are driven by:**
  a. aging infrastructure in advanced economies
  b. higher growth and growing weight of emerging/developing countries in global economy.
  c. structural change in EMDCs including rapid urbanisation from around 3.5bn now (50% of 7+bn) to 6.5bn by 2050 (70% of 9+bn). ***Once in history transition.***

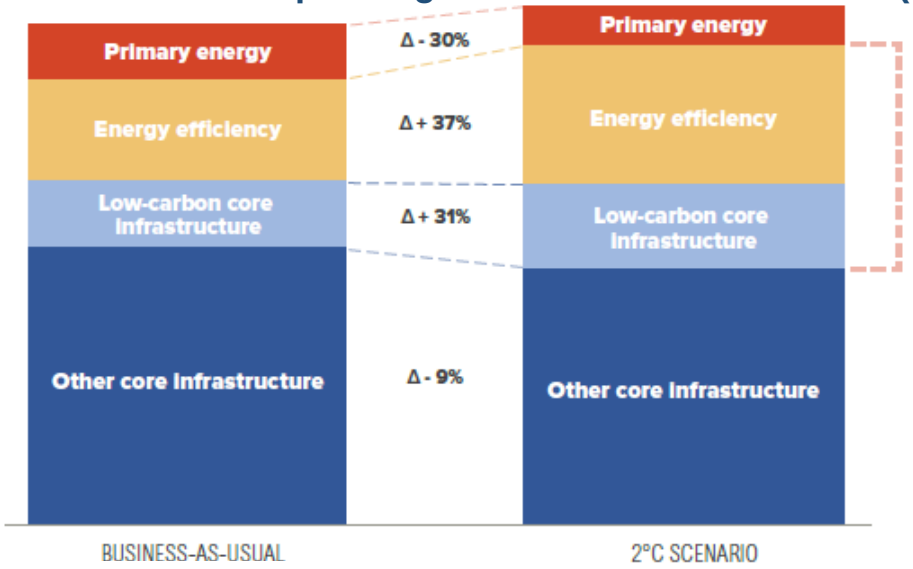
- **Altogether $80-$90 trillion in infrastructure investments required over next 15 years—more than the current existing stock. One way or another, most of this infrastructure will get built, but how it is done will have a crucial bearing on outcomes for growth, development and climate.**

Magnitude and nature of challenge of scaling up

- Over the past decade, annual infrastructure investment globally has increased by $1 trillion reaching an estimated $3.4 trillion in 2014. China alone accounts for around 40 percent of the global investment in infrastructure, more than the developed world combined.
- Given huge investment requirements, annual infrastructure investment will need to rise to $5.5 -$6 trillion per year on average between 2015 and 2030.
- EMDEV countries will account for almost 70 percent of the increase with developing countries other than China accounting for the bulk of this increase.
- A major shift will also be needed in the composition of infrastructure towards low-carbon investments.
- The overall costs for infrastructure investments are not any higher because of significant reduction in costs of low-carbon technologies and downstream savings. Low-carbon investments however entail higher proportion of upfront capital costs.

Investing in sustainable infrastructure requires a shift in investment but does not need to cost much more

Infrastructure spending needed for a 2°C scenario (2015-2030, percentage change)



- Primary energy: extraction of oil, gas and coal
- Energy efficiency: buildings, energy and transportation
- Low-carbon core infrastructure: renewable energy, nuclear, CCS, low-carbon transport (e.g. light rail and Bus Rapid Transit systems), climate-proofed water and sanitation including some adaptation infrastructure (e.g. sea walls and flood protection)
- Other core infrastructure: standard water/sanitation, high-carbon transport (e.g. roads), energy production, and telecommunications

Source: Global Commission on the Economy and Climate, 2016 and 2014, and Bhattacharya et al., 2016

The catalytic role of development banks

- There is no shortage of world savings but major obstacles in **transforming investment opportunities into real investment demand** and major difficulties in bringing forward the **right kind and scale of finance at the right time.**
- This requires strong government policy; but also **key role for MDBs** around supporting investment by enhancing the quality of the project, reducing risk and **crowding in private finance.**
- **The presence of a development bank imparts confidence, reduces risks, brings relevant instruments and encourages participation of other sources of financing** both at the initial phase and once the project reaches maturity.
- **Brings down cost of capital:** crucial for volume and sustainability (quantity and quality).
- **As trusted conveners they can help bring together governments, the private sector, investors and civil society and help establish replicable and scalable models.**
- **MDBs can also help to catalyze change to make infrastructure more sustainable.**

The necessary expansion of MDBs (1)

- **MDBs** can play a pivotal role in meeting the infrastructure challenge**, but will need to increase their infrastructure lending five-fold over the next decade from around $30-40 billion per year to over $200 billion per year in order to help meet overall infrastructure financing requirements** (Bhattacharya, Oppenheim, & Stern, 2015).

- **Augmenting the lending capacity of the MDBs** is also the most effective way for developed countries to meet their commitments on climate finance and ensuring that this finance has the maximum development and climate impact. Paris COP21 contains the $100 billion p.a. commitment on flows from developed to developing countries.

- Together with ODA/Climate Finance and export credit agencies, this total pool of **official development finance could be used to mobilise a much larger sum of private capital.**

- The key will be to put together **viable and well-structured financing packages on which MDBs have a comparative advantage.** Based on past experience it should be possible to mobilise anything between two and four times the amount of total private capital.

The necessary expansion of MDBs (2)

- **Newly established multilateral development banks, such as the Asia Infrastructure Investment Bank (AIIB) and the New Development Bank (BRICS Bank), are increasingly a source for financing infrastructure in emerging economies.**
    - The first four investments of the BRICS Bank, for a total of US$811 million in loans, as announced in April 2016, are in renewable energy or clean grid infrastructure development in Brazil, China, India and South Africa.
    - AIIB commitment to “clean and green”.
- **The presence of an MDB or a national development bank brings extra confidence in policy, skills and the appropriate mix of equity, long-term loans and other kinds of finance. Can take projects through difficult initial phases and make them suitable for institutional investors.**
- **Mobilising both long-term debt finance and the large pool of institutional investor assets for low-carbon infrastructure can boost confidence and mutual reinforcement.**
- **The examples set can have further powerful multipliers**.
- **All this can take us to the trillions needed for sustainable infrastructure.**

Structure

1. Risks, the required action, the global agenda
2. Urgency and scale
3. The 21st century growth story: delivering on the global agenda
4. Building sustainable infrastructure
5. The next 10 years- prospects for the future

Urgency and opportunities for ramping up ambition (1)

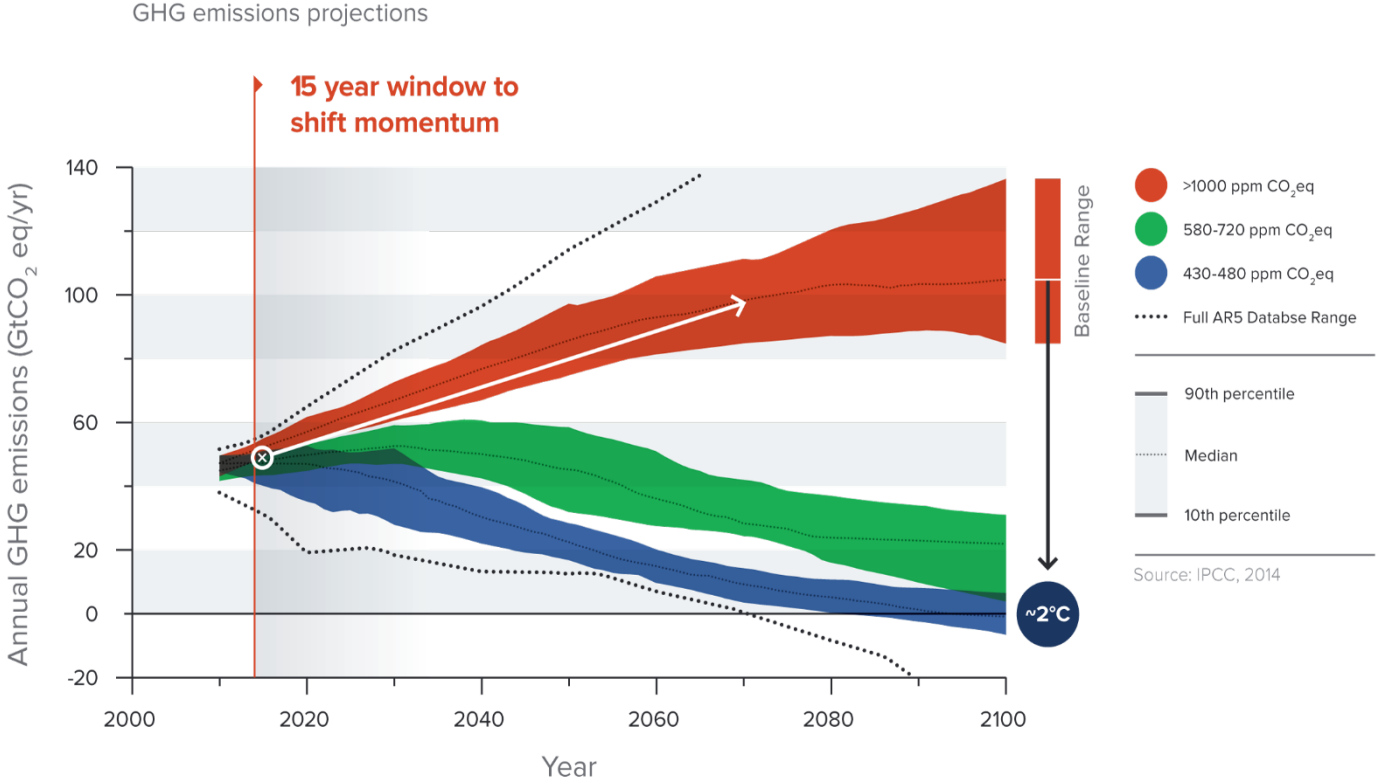
- **Our climate performance is off-track**

→ importance of the next 10 years

- **Danger of lock-in**

→ importance of infrastructure

- **The next 10 years will determine the next 20**



Source: IPCC (2014) in New Climate Economy, 2014

Urgency and opportunities for ramping up ambition (2)

- The window for making the right choices is uncomfortably narrow because bad infrastructure and other investments can lock in capital, technology and emission patterns for decades. And remaining carbon budget is shrinking rapidly (ratchet effect of flow-stock process, i.e. emissions to concentrations).
- On the other hand, much clearer recognition now, as evidenced in Paris, of both the immense risks and great attractions and opportunities that lie in low-carbon climate-resilient growth (Better Growth, Better Climate 2014; Stern, 2015).
- Time is opportune: low interest rates; rapid technological change (energy production and use, digital, materials, biotech, construction); and the opportunity to shape the new infrastructure.
- BUT if we do not take the opportunities rapidly, **2°C target will be out of reach, with grave consequences.**
- **Next twenty years will be decisive in world history**: deep responsibility as well as great opportunity. Policies and actions in next 10 years will shape these 20 years.

The next 10 years can clear the way to a much better future

We can create a world in which

- **Our energy systems are efficient and clean:**
  - Radical improvement in energy efficiency across industry, heating and transport.
  - The power systems of most countries are largely clean, and coal use ended (unless burned with CCS).
  - The production of new electric and clean transport will have overtaken production of new fossil-fuel-powered land transport.
- **Our cities are healthy, innovative, efficient, resilient places to live and work:**
  - Cities tackle greenhouse gas emissions and air pollution together, e.g. through reducing congestion, promoting low-carbon transport, efficiency in building, ...
  - Cities will have developed much greater climate resilience, particularly in developing countries.
- **Policy sets the framework for the private and financial sector:**
  - Every country is implementing nationally determined contributions consistent with limiting global warming to well below 2°C.
  - The major economies have doubled their public and private investment in clean R&D.
  - Widespread adoption of national policies to reduce greenhouse gas emissions, including strong prices on carbon.
- **Our food systems are resilient and much lower carbon, our ecosystems thriving:**
  - Deforestation has ended and programmes of land rehabilitation and of afforestation are widespread.
  - Agriculture has become more sustainable, by lowering emissions and becoming more resilient to the impacts of climate change.

Response must be swift and strong now, but also deliver radical change later this century

- We must act strongly now and build the right infrastructure within the next 10 to 20 years.
- BUT agenda for action is not just about building the right infrastructure, but also about what we invent and how we innovate.
- Around **three-quarters of energy use and emissions are outside the power sector**: heating, industry, transport. Innovation and research crucial in these areas. Work of **Energy Transition Commission**.
- Possibilities include hydrogen for heating; CCS for industry; electricity and hydrogen for land transport and biofuels for air. This could take power sector to closer to half of energy – can make power sector entirely clean.
- Far greater **resource efficiency everywhere**; circular economy.
- Research and innovation crucial.

What can be done to deliver negative emissions (1)

- Stabilisation of temperature requires stabilisation of concentrations which requires zero net emissions, which requires negative in some activities/areas if other activities/areas are positive.
- Also dangers of overshooting concentrations consistent with COP21 and well below 2°C, thus requiring negative emissions to reduce overall concentrations (see Thomas et al, 2016).
- What can be done to achieve negative emissions?
  - CCS likely to play an important role in reducing emissions (see IEA, 2015).
  - Ten countries explicitly refer to CCS in their Intended Nationally Determined Contributions (INDCs), representing about a third of global emissions; including key CCS players such as China, Canada and Saudi Arabia, along with less developed countries like Malawi, which expressed interest in the technology conditional on economic feasibility.

What can be done to deliver negative emissions (2)

- Not many options for sustained negative emissions on scale:
  - (i) Growing and intensifying forest cover.
  - (ii) Rehabilitation of degraded land and capture in soil.
  - (iii) Bio-energy with CCS.
  - (iv) Extracting CO_2 and other GHGs in other direct ways.
- First and second of these could play a strong role for a while but, at some stage, forests etc. would stabilise (cannot increase indefinitely).
- Some innovative attempts on iv but seems long way off at present.
- Strong priority for research.
- Limitations on negative emissions emphasises importance of radical reductions in emissions across economy.

Conclusions: taking the opportunities of the next 10 years

- Transition to low-carbon growth gives more than a fundamental reduction in climate risks; it is an opportunity for **a much more attractive, sustainable and inclusive path for development** which delivers on the global agenda for growth, climate responsibility and the Sustainable Development Goals.

- With strong policy that sets clear expectations, **market forces and private sector initiatives have a central role in shifting economies onto new low-carbon pathways**.

- "**Political will**" is critical to making the radical changes necessary.

- That will depend on **understanding** of great attractions of alternative paths as well as of the great risks from climate change.

- "**Power of examples**" will be of great importance.

- So too will be **leadership** in politics, business and civil society.

Conclusions: prospects; optimism about what we can do, anxiety about what we will do

- There are tremendous opportunities for a dynamic few decades of **innovation, creativity and growth**.
- **Cities where we can move and breathe** and ecosystems that have a change of flourishing.
- We rise to the two defining challenges of our century: **overcoming poverty and managing climate change**.
- We can make this the **best of centuries**; but it could be the worst of centuries.
- I am very **optimistic about what we can do**. An understanding of what is possible is a **necessary condition for action**.
- But will it be **sufficient**? There lies both the **responsibility and the anxiety**.

References

Bhattacharya, A., Oppenheim, J., & Stern, N., 2015. Driving Sustainable Development through Better Infrastructure: Key Elements of A Transformation Program. Global Economy and Development at Brookings, Working Paper 91.

Bhattacharya, A., Meltzer, J., Oppenheim, J., Qureshi, M.Z., & Stern, N., 2016. Delivering on Sustainable Infrastructure for Better Development and Better Climate. Available at http://newclimateeconomy.net/content/2016-nce-report-launch-sustainable-infrastructure-imperative

Coady, D., Parry, I.W., Sears, L., & Shang, B., 2015. *How Large Are Global Energy Subsidies?,* International Monetary Fund.

Floater, G., Rode, P., Robert, A., Kennedy, C., Hoornweg, D., Slavcheva, R. and Godfrey, N. (2014): *Cities and the New Climate Economy: the transformative role of global urban growth*. New Climate Economy Cities Paper 01. LSE Cities. London School of Economics and Political Science

International Energy Agency (IEA), 2015. *Carbon Capture and Storage: The solution for deep emissions reductions*. Paris: IEA. Available at https://www.iea.org/publications/freepublications/publication/carbon-capture-and-storagethe-solution-for-deep-emissions-reductions.html

Pfeiffer, A., Millar, R., Hepburn C., & Beinhocker, E., 2016. The '2°C capital stock' for electricity generation: Committed cumulative carbon emissions from the electricity generation sector and the transition to a green economy, *Applied Energy*, http://dx.doi.org/10.1016/j.apenergy.2016.02.093.

Stern, N., 2015. *Why Are We Waiting? The Logic, Urgency and Promise of Tackling Climate Change*. Cambridge: MIT Press.

Thomas, R., Graven, H., Hoskins, B., & Prentice, I.C., 2016. *What is meant by 'balancing sources and sinks of greenhouse gases' to limit global temperature rise?* Grantham Institute Briefing Note No 3. September 2016. Available at http://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/briefing-papers/Balancing-sources-and-sinks-of-greenhouse-gases-Grantham-BN3_web.pdf