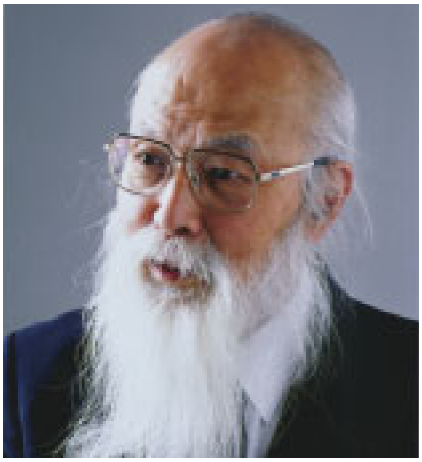
2009

Blue Planet Prize

Professor Hirofumi Uzawa (Japan)
Member of The Japan Academy
Professor Emeritus, The University of Tokyo

Lord (Nicholas) Stern of Brentford (UK)
Professor, The London School of Economics



GIFT:
This Blue Planet we live on
Is blessed to hold life
In the universe full of stars brilliantly shining

We humankind
Are we spending the days by embracing from deep in our heart?
The happiness of being born on this blue planet of life

As a tiny life born on this planet
Caring other lives, cherishing each other
Are we pursuing in full, the meaning of our lives?
By truly giving our appreciation
To the blessings of the "planet of life" Earth

It is our great pleasure
If the film this time
Served you to think
About the happiness of living on this blue planet
By extending your thoughts
To the gifts from the "planet of life" Earth

Selected from the Slide Show Presented at the Opening of the Awards Ceremony

His Imperial Highness Prince Akishino congratulates the laureates

Their Imperial Highnesses Prince and Princess Akishino congratulate the laureates at the Congratulatory Party

The prizewinners receive their trophies from Chairman Seya

Professor Hirofumi Uzawa

Lord (Nicholas) Stern of Brentford

Dr. Hiroyuki Yoshikawa, Chairman of the Selection Committee explains the rationale for the determination of the year's winners

Hiromichi Seya, Chairman of the Foundation delivers the opening address

Professor Ichiro Kanazawa, President, Science Council of Japan (left) and Mr. David Warren, United Kingdom Ambassador to Japan, congratulate the laureates

Profile

Lord (Nicholas) Stern of Brentford

Professor, The London School of Economics

Education and Academic and Professional Activities

1946	Born in U.K.
	Bachelor of Arts degree in mathematics at Cambridge (1967) , and Doctor of Philosophy in economics at Oxford (1971)
1970-1978	Lecturer in Economics, Oxford University
1978-1986	Professor of Economics at University of Warwick
1986-1993	Professor of Economics at London School of Economics
1994-1999	Chief Economist and Special Counsellor to the President of the European Bank for Reconstruction and Development
2000-2003	Chief Economist and Senior Vice-President of the World Bank
2003-2007	Second Permanent Secretary at H. M. Treasury,
	Head of the Government Economic Service, appointed to lead the writing of the Report of the commission for Africa 2004-5, conduct a review of the economics of climate change, which led to the Stern Review 2006: The Stern Review was released on 30 October 2006
2007-	I.G. Patel Professor of Economics and Government at London School of Economics, Director of the newly created India Observatory within the Asia Research Centre at LSE, and Chair of the Grantham Research Institute on Climate Change and the Environment
	Lord Stern of Brentford, cross-bencher in the House of Lords

(As of June, 2009)

Lord Stern released the Stern Review on the Economics of Climate Change on October 30, 2006, which discusses the effect of climate change and global warming on the world economy with the aid of recent scientific data and economic models, and has since published extensivery on the subject, including the Richard Ely Lecture at the American Economic Association (American Economic Review May 2008) and his recent book (entitled The Global Deal in the USA and A Blueprint For A Safer Planet, UK) To avoid the devastating effect of global warming, the Review made it clear that the world requires urgent action to implement global policies: cooperation from all countries is crucial. The Review stresses the concept of equity, including, both the responsibility of developed countries to developing countries and intertemporal considerations, the responsibility of the current generation to provide a sustainable planet for future generations.

The Review was discussed at the Conferences of the Parties to the United Nations Framework Convention on Climate Change in 2006 and 2007 (COP12 and COP13) and received much public attention. Backed by the recent scientific data and economics, Lord Stern's work makes a significant contribution, not only through promoting the understanding of academic research, but also by informing the public about the potentially immense toll of global warming. The Review also had a significant impact on governments and policy makers by proposing viable policies to mitigate and adapt to climate change. Lord Stern continues to take every opportunity to discuss and influence policy makers across the globe, this includes assisting concerned parties to understand the consequences of global warming and understanding of the necessity of urgent action.

From Mathematics to Development Economics

Lord Stern was born on 22 April 1946 in London UK. He earned his Bachelor of Arts degree in mathematics at Peterhouse, Cambridge, and his Doctor of Philosophy in economics at Nuffield College, Oxford. His experiences in Mexico in 1964, Turkey and Iran in 1966 and Ethiopia in 1967 generated a lifelong interest in development economics, and particularly with poverty and the study of the development process in low-income countries. From 1969, early on his career, he began research in development economics, based first in Kenya and then in India, including the Uttar Pradesh village of Palanpur which he has visited regularly since 1974, researching the economic transformation of the village and the close relationship between overcoming poverty and environmental issues and climate changes have been key issues for his work, including in the Stem Review.

He was a lecturer at Oxford University from 1970 to 1977, and served as a Professor of Economics at the University of Warwick from 1978 to 1987. He taught from 1986 to 1993 at the London School of Economics, becoming the Sir John Hicks Professor of Economics. From 1994 until 1999 he was the Chief Economist and Special Counsellor to the President of the European Bank for Reconstruction and Development. He was the Chief Economist and Senior Vice-President of the World Bank from 2000 to 2003 where continued his work on the problems of world poverty.

In 2003 Lord Stern became Second Permanent Secretary at H. M. Treasury, initially with responsibility for public finances, and head of the Government Economic Service. He led the writing of the Report of the commission for Africa 2004-5 and in July 2005 he was appointed by the UK government to conduct a review on the economics of climate change, which led to the publication of the Stern Review on 30 October 2006. The Review gained global media attention for its stark assessment of climate change and examination of comprehensive policies to prevent the likely outcomes of unmitigated climate change. Lord Stern attended COP-13 in Nairobi in Kenya in 2006 and COP-14 in Bali, Indonesia (2007 United Nations Climate Change Conference) to promote the understanding of the Review worldwide.

In June, 2007 Lord Stern became the first holder of the I. G. Patel Chair at the London School of Economics and Political Science. In 2008 he was appointed Chair of the Grantham Institute for Climate Change and the Environment, and head of the newly created India Observatory within the Asia Research Centre at LSE. Sir Nicholas Stern became Lord Stern of Brentford in December 2007, appointed to the House of Lords.

Measures Proposed to Deal with Global Warming

The Stern Review is the most comprehensive review on the economics of Climate change. The Review analyses the economic costs of climate change, the costs and benefits of actions to reduce emissions, and considers policies to address climate change. The Review provides clear conclusions concerning the consequences of unmitigated climate change: if we take no action to control emissions and continue along a business as usual (BAU) pathway, we run severe risks of a transformation of the planet which would lead to large-scale migration involving hundreds of millions of people and global conflict. This is a challenge of risk management of the highest order of importance. Expressed in more narrow cost-benefit analysis terms the Review estimated total costs over next two centuries equivalent to at least 5% (up to 20%) of world GDP each year.[*1] Moreover, given the direct impact on the environment and human health, some recent scientific evidence suggests a disproportional share of the climate change burden will fall on the poor regions of the world.

By contrast, if we act now, the cost of action to avoid the most severe impacts of climate change are estimated at around 1% to[*2] of world GDP each year. New technologies and innovation can enable the world to avoid a climate disaster and maintain strong economic growth. Attempting to continue with high-carbon growth will not only severely damage the planet and humans and other life, it will stop or reverse growth.

To cope with the significant challenge of climate change, the Review concluded that a shared global perspective on the urgency of the climate change is required; long-term policy goals to address global warming, and an international approach based on multilateral frameworks and coordinated action, are essential to respond to the vast scale of the Challenge.

To control global warming, the Review examines national and international policies and indicates that four elements of policy are required. The first is carbon pricing policy worldwide, through taxation, emission trading or (an implicit price) regulation. The second is technology development policy, to encourage low-carbon and high-efficiency product technologies. Third is the policy to remove barriers to energy efficiency, and to inform and educate firms and individuals on possibilities. The fourth policy response is adaptation policy to deal with the climate change to which we are already committed.

An effective response to climate change will depend on creating the conditions for international collective action, for example effective policies to halt deforestation across the globe. After the release of the Review, Lord Stem has traveled extensively across the world to promote policy to curb emissions.[*3]

Lord Stern argues that developed countries are responsible for the bulk of the current stock of greenhouse gases in the atmosphere. They are also richer and have better access to technology. Therefore, they have a responsibility to lead efforts to reduce emissions and to find ways of sustaining development in a more hostile climate. They must do this directly through their own action and providing finance, directly or through trading for action in developing countries. In addition, given that developing countries will be responsible for the majority of the increase in greenhouse gas emission in the future, the sharing of low-carbon technology between developed countries and developing countries is an essential requirement of any effective policy response.

Preservation of the global environment is indispensable to sustain the development of the world economy and the future welfare of society. It is the responsibility of the current generation to hand a safe and sustainable planet to future generations. Stern's work, including in The Stern Review, clearly defines what must be achieved to fulfill our responsibility for avoiding a major climate disaster. If disastrous climate change does occur, the developing countries and the world's poorest will be hardest hit; to prevent this tragedy the world must act with urgency. The clear messages in Lord Stern's work concerning developing countries coincide with his profound understanding of the severe situation of poor people in developing counties and his serious concern over the bleak future in the case of climate inaction.

As an economist, Lord Stern has engaged in studies of economic development, economic theory, tax reform, public policy, the role of the state, and the economic transition from command to market economies. In the year 1974 and 1975, he spent 8 months in a rural village in north east India; and he wrote books about development of tea plantations in Kenya and agricultural change in India. In addition, he has written books on crime and criminal statistics in UK, financial affairs, public development, "A strategy for development" 2002, "Growth & Empowerment: Making Development Happen" 2005, "A Blueprint for a Safer Planet" 2009, and over 100 published academic papers.

Lord Stern expressed the pressing situation of climate change as following:

"There is still time to avoid the worst impacts of climate change, if we act now, we act strongly and we act internationally." Already three years have passed since the Review was made public, urgent action to combat global warming is long overdue.

Notes

*1: After the Review was published, scientists concluded that the capacity of the planet to absorb CO_2 is less that the level assumed in the Review.
Considering this fact, Lord Stern now warns that the impact of climate Change is much larger than the review predicted.
Guardian 25 March 2008

*2: Lord Stern mentioned that the evidence now shows that climate change is happening faster than had been previously thought. Therefore emissions of greenhouse gases need to be reduced even more sharply. Owing to this increase in greenhouse gases, it will cost up to 2% of global GDP each year to address climate change.
Guardian 26 June 2008, New Scientist 21 January 2009

*3: Detailed policy. Developed countries to reduce their greenhouse gas emissions by at least 80%, in order for the world to achieve an overall reduction in global emissions of 50% by 2050.
Substantial trade between countries, including rich and poor countries, in greenhouse gas emissions, to keep down costs and help finance climate investment in developing countries.
A major reform of the Clean Development Mechanism, a Kyoto protocol mechanism that allows developing countries to sell emission reductions, but does not penalize them for emissions themselves.
A programme, $10-15bn per year, could stop up to half the deforestation. Urgent promotion of technologies such as Carbon Capture and Storage (CCS) is needed to curb the emissions from coal-fired electric power generation.
Rich countries honour 0.7% GDP in aid, by 2015 to developing countries for mitigating the impact of climate change.
Guardian 29 November 2007

Essay

Climate Change, Public Policy and a New Wave of Technological Change

Lord (Nicholas) Stern of Brentford

Science tells us that the problems created by the accumulation of emissions of greenhouse gases (GHGs) are potentially immense. Under anything approximating business-as-usual (BAU) there is a substantial probability (perhaps as high as 50%) that in a century or so global average temperatures could reach 5ºC above the 19th century, temperatures not seen on the planet for around 30 million years. The potential climate change associated with such temperatures would likely transform the lives and livelihoods of billions of people, including where hundreds of millions could live. Resulting population movements could lead to extended, severe and widespread conflict. These are the scale of the stakes that follow from the science.

The potential effects are subject to major uncertainties, they appear with long lags, and the effect of a kilogram of GHG emissions is independent of whom or where are the emitters (emissions are "public bads" in the language of economics). The combination of the magnitude, the uncertainty, the lags in the consequences, and the 'publicness' of the causes, all of which follow from the science, makes the politics and economics of policy supremely difficult (Stern, 2012).

It is hard for people to understand the scale of risk from climate change. More generally, misunderstanding of the meaning of uncertainty and how to respond are pervasive in both public and private decision-making. And the lags are compounded by ratchet effects and irreversibilities: once carbon-dioxide, the most important of the GHGs, is in the atmosphere, it is likely to stay for many decades. Further, capital equipment and infrastructure can last for a few decades, locking in high-carbon structures. Thus if decisions are postponed until the effects are very clear and the scale is demonstrated, it may be difficult, extremely costly, or impossible to extricate ourselves. Or we may have to consider very risky and badly understood alternatives such as geoengineering, which themselves may carry immense and potentially damaging consequences. The publicness of the cause may tempt people to leave action to others on the articulated grounds that each individual contribution is small or they may decline to act because they do not have confidence that others will act.

We have a problem of risk management and public action of immense importance whose scientific logic makes the formulation, decision-making, and implementation of policy extremely difficult. The policy challenge is, however, far from insoluble; indeed if it were, it is likely that the future for our children and grandchildren would be dire.

The building of the political will to take the radical decisions necessary will require the widespread and shared understanding of two fundamental propositions. So far, we as scientists, social scientists, and communicators have not made sufficient progress in explaining and demonstrating these propositions. The two propositions concern first, the scale of the risks and the urgency of action and second, the nature and attractiveness of the new energy-industrial revolution which is required. They are the subject of the second and third sections of this brief paper. The remainder of this first section is devoted to the key elements of economic policy for the management of climate change and broader issues of sustainability beyond climate change.

Emissions of GHGs are not the only market failure relevant to the management of climate change. There are crucial market failures concerning: research, development and deployment; networks and grids; long-term risk and capital markets; property markets; and information more generally. Further, there are failures in the valuing and understanding of co-benefits of action on climate change (beyond the fundamental benefits of reducing the risks of climate change) and embedding these in policy. These arise especially around the valuation of ecosystem services and biodiversity issues which require close attention in their own right as well as being profoundly affected by action or inaction on climate change.[2]

Each of these requires careful attention: thus the problems of market failure associated with promoting action on GHGs go beyond the fundamental market failure of the unpriced "externality" of emissions. That market failure is indeed fundamental and is a first and crucial element of any policy foundation, but policy will fail to generate the scale and urgency of the response required if it stops there. The demonstration of ideas and new techniques helps others and thus should be fostered; networks depend on interaction and require government policy to work effectively and so on. Policy in relation to each of the failures described should be based on careful analysis of the origins of the failure itself and thus how it can best be tackled.

Scale of the Risks and the Dangers of Delay

Global GHG emissions are currently around 50 billion tonnes of carbon dioxide-equivalent (CO_2e) per annum and are growing strongly, mainly due to carbon intensive growth in the developing world. As the carbon cycle is unable to absorb all of the world's annual emissions, concentrations (stocks) of GHG emissions in the atmosphere have increased, to around 440ppm of CO_2e today. We are currently adding at a rate of around 2.5ppm per year. This rate is rising. Thus if we continue with something like BAU over the course of this century we would likely add at least 300 ppm, taking concentrations to around 750 ppm CO_2e or higher at the end of the century or early in the next. Such a path could bring somewhere in the region of a 50-50 chance of an eventual warming of more than 5ºC relative to mid-19th century levels[3]. A rise of 5ºC is immense: the planet has not seen these temperatures for more than 30 million years.

The world's current commitments to reduce emissions, as pledged in the Appendices to the Copenhagen Accord and confirmed in the Cancun agreement and recently at Durban, are consistent with at least a 3ºC rise (again with roughly a 50-50 chance of above or below). The world has not seen 3ºC for around 3 million years. *Homo sapiens* has experienced nothing like this, being present for only around 200,000-250,000 years, and our civilisations, in terms of arable farming, villages, towns and so on, have been here for only 8,000 or 9,000 years, since the emergence from the last ice age, i.e. during the Holocene period, during which time average temperatures have fluctuated in a quite narrow range of between ±1ºC.

Such warming would likely cause disruption on a huge scale to local habitats and climates, for example through flooding, desertification, and water scarcity. Hundreds of millions of people, perhaps billions, would probably have to move, with the associated risks of severe and extended conflict. The great advances in development of the last few decades, which have seen hundreds of millions of people in developing countries rise out of income poverty, substantial improvements in health and life expectancy, large reductions in fertility rates, and major advances in education and literacy, would likely be put at risk.

The scale of the risks and the inherent uncertainty around these projections clearly imply that policy analysis of climate change must be framed in terms of risk-management. The potential risks are huge and the associated probabilities are not small.

The uncertainty present in these projections may suggest to some that delay whilst we learn more is the best response, rather than early and strong action to reduce emissions. That would be a profound mistake. First, the flow-stock process, from emissions to increasing concentrations of GHGs in the atmosphere, with CO_2, in particular, very long-lasting in the atmosphere, implies that we have a ratchet effect. Processes to remove emissions from the atmosphere or prevent solar energy reaching the earth, known as geoengineering, are undeveloped, largely untested and are also likely to involve significant risks. See the 2009 Royal Society report and Reekie and Howard (2012). Second, much of infrastructure and capital investment can result in technological "lock-in". With little action the long life times of much of the relevant high-carbon infrastructure and network investment could imply that the lock-in could last for many decades to come. Delay is clearly very dangerous: we are already at a difficult starting point in terms of concentrations of GHGs and weak action or inaction for a decade could make stabilisation of concentrations at levels that reduce the risks to acceptable levels, in particular 2ºC, very difficult.

To embark on strong action now, if the science turns out to be wrong and the risks are small, would leave us with a more energy efficient and bio-diverse economy and new technologies, even though ex post we might have wished there had been somewhat smaller investment in these areas. On the other hand, if the science turns out to be right, and we ignore the risks, we would be in an extremely difficult position from which it would be very hard to extricate ourselves. Given this logic, basic decision theory or common sense points to strong action, particularly since the science is very likely to be right. To argue for weak or delayed action involves claiming to be pretty sure the risks are small—an extraordinary position given 200 years of cumulative scientific analysis—and/or that delay has only modest downside.

Size of the Response and the New Energy-industrial Revolution

Most nations now agree, as expressed in the current global negotiations (the agreement at Cancun at the UNFCCC meeting of December 2010), that limiting the rise in global temperature to 2ºC is necessary in the sense that levels above this are (sensibly) regarded as dangerous. To achieve this goal, with a 50-50 probability, global emissions would need to fall from current levels to pass well below 35 billion tonnes of CO_2e in 2030, and well below 20 billion tonnes of CO_2e in 2050. These "global constraints" should be at the heart of discussions and of the understanding of action.

Reducing absolute emissions levels by a factor of at least 2.5 in 40 years would require a reduction in emissions per unit of output by a factor of around 8 if the world economy grows over 40 years by a factor of around 3 (equivalent to an annual world GDP growth rate of around 2.8%). Emissions reductions on this scale should surely be regarded as a new energy-industrial revolution. The transition to low-carbon growth and the energy-industrial revolution represent a far more attractive path than the high-carbon, dirty and environmentally destructive path that has gone before. The transition is likely to be a period of innovation, creativity and growth, and will involve substantial investment across the economy. And low-carbon growth is likely to be cleaner, safer, quieter, more energy secure and more bio-diverse. Low-carbon growth is the genuine growth option; an attempt at high-carbon growth will self-destruct.

The study of past periods of economic/technological transformation has much to teach us here. Past industrial revolutions, e.g. steam and the railways, and much more recently the information, communications and technology (ICT) revolution, which continues (Figure 1), involved a transformation that saw two or more decades of strong innovation and growth, with investment flowing to those pioneer countries and businesses that showed leadership and embraced the transition (see, for example, Perez, 2002 and 2010). Such transformations involve periods of 'creative destruction' (in the tradition of the economist Joseph Schumpeter), where new firms and ideas drive out the old, generating a dynamic period of innovation, opportunity, employment and economic growth. Countries and states such as China, Korea, Germany, the Scandinavian countries, and California are leading the transition with the size of their low-carbon markets growing strongly. The costs of low-carbon technologies, such as solar PV and off-shore wind power have declined rapidly over recent years and similar cost reductions are expected in the future as their deployment accelerates.

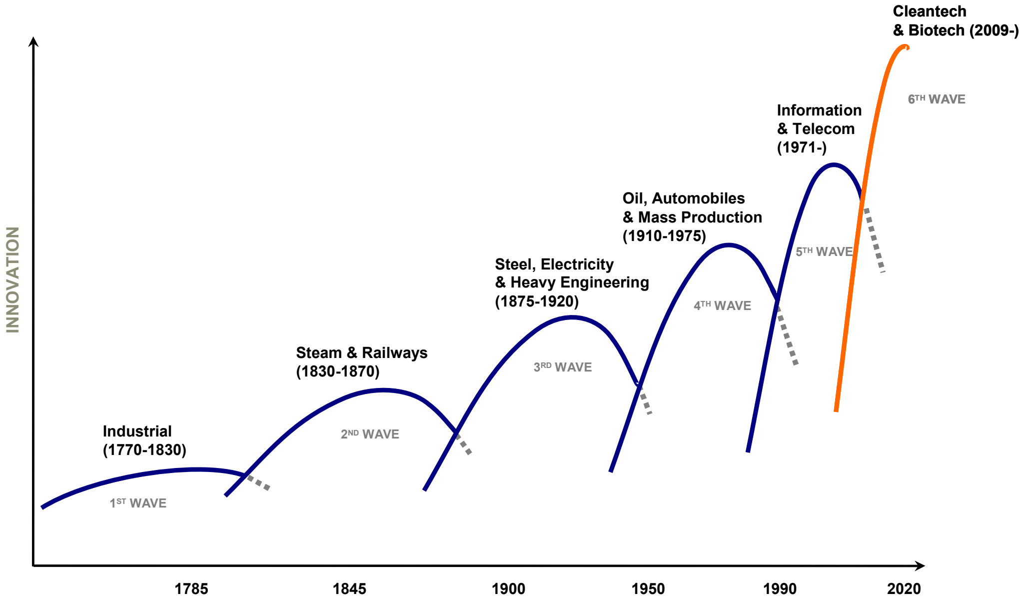


Figure 1
Waves of Innovation

Source: DONG Energy (2009); diagram based on Perez (2002) drawing on report by Merrill Lynch (2008) (schematic not precise quantitative vertical axis).

The transition will require strong action to reduce emissions across all countries and all economic sectors. Energy efficiency will be central to the response, as will the introduction of new low-carbon technologies and strong and determined action to slow and halt deforestation. This will involve the implementation of transparent, long-term and credible public policies (to address the market failures) and public investments that create a positive environment for innovation and change. They should take careful account of and be integrated with policies to protect ecosystems and biodiversity.

As this transformation progresses the world must also be prepared to adapt to the climate change to which we are already committed from past and future emissions. We have to manage the unavoidable as well as avoiding the unmanageable. We are already outside the temperature range of the Holocene period when our societies developed. Another 1-1.5ºC which appears very likely will require major adaptation to changing weather and climate patterns. There should be close intertwining with mitigation and development—indeed it is a mistake to separate them excessively in terms of organization and implementation. Much of irrigation and water management should combine mitigation, adaptation and development, similarly buildings, city management, power and so on. The stronger the emissions reduction, the less the necessary scale of adaptation but given what we have already done and are doing on emissions the scale of adaptation will have to be large.

We are already starting to see emissions reduction policies introduced in many countries. But action will have to be stronger and more rapid, more coordinated, and extend more broadly across the many relevant market failures if the level of investment and pace of change necessary to avoid dangerous climate change are to be achieved. Delay is dangerous and now is the time to accelerate. The world economy risks a prolonged slow down as a consequence of the financial and economic crises of the last few years. Low-carbon growth is the only sound basis for a sustainable recovery.

References

Bowen, A. & N. Ranger, 2009, *Mitigating Climate Change Through Reductions in Greenhouse Gas Emissions: The Science and Economics of Future Paths for Global Annual Emissions*, Policy Brief, December, Centre for Climate Change Economics and Policy, and Grantham Research Institute on Climate Change and the Environment. www2.lse.ac.uk/GranthamInstitute/publications/Policy/docs/PBMitigatingBowenRangerDec09.pdf.

Bruntland, et al, 2012, *Environment and Development Challenges: The Imperative to Act*, Blue Planet Laureates, Background Paper prepared for a submission to the Rio+20 UN conference in June 2012.

DONG Energy, 2009, *Rethinking energy*. Ascent Business Leadership Forum 2009, Presentation, 22 October.

Merrill Lynch, 2008, *The sixth revolution: the coming of Cleantech clean technology*, Industry Overview. Online at: www.responsible-investor.com/images/uploads/resources/research/21228316156Merril_Lynch-_the_coming_of_clean_tech.pdf.

Perez, C., 2002, *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages*, Edward Elgar, UK.

Perez, C., 2010, *Full Globalisation as a Positive-Sum Game: Green Demand as an Answer to the Financial Crisis*, www2.lse.ac.uk/publicEvents/events/2010/20100518t1830vOT.aspx.

Royal Society, 2009, *Geoengineering the climate: Science, governance and uncertainty*, September.

Reekie, T. and W. Howard, 2012, *Geoengineering*, Occasional Paper Series, Office of Australia's Chief Scientist, Australian Government, Issue 1. http://www.chiefscientist.gov.au/wp-content/uploads/47019_Chief-Scientist-_OccassionalPaperSeries_lores.pdf.

Stern, N., 2012, Climate Change and the New Industrial Revolution: What we risk and how we should cast the economics and ethics, Lecture 1, Lionel Robbins Memorial Lecture Series, London School of Economics and Political Science, February 21. http://cep.lse.ac.uk/_new/events/event.asp?id=140.

The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations, 2011, (ed.) Pushpam Kumar, Earthscan Volumes.

The Economics of Ecosystems and Biodiversity in National and International Policy Making, 2011, (ed.) Patrick ten Brink, Earthscan Volumes.

The Economics of Ecosystems and Biodiversity in Business and Enterprise, 2011, (ed.) Joshua Bishop, Earthscan Volumes.

The Economics of Ecosystems and Biodiversity in Local and Regional Policy Management, 2012, (eds) Heidi Wittmer, Haripriya Gundimeda, Earthscan Volumes.

UNFCCC, 2011, *Report of the Conference of the Parties on its sixteenth session, held in Cancun from 29 November to 10 December 2010*, March. http://unfccc.int/documentation/decisions/items/3597.php?such=j&volltext="cancun%20agreements"#beg.

Notes

1. I am very grateful to James Rydge for his guidance and support.
2. The Rio+20 conference of June 2012 rightly places strong emphasis on these bio-diversity issues. See The Economics of Ecosystems and Biodiversity (TEEB) Volumes.
3. See, for example, Bowen and Ranger (2009).

Lecture

Creating a Global Agreement on Climate Change: Responsibilities and Opportunities

Lord (Nicholas) Stern of Brentford

Introduction

Avoiding dangerous climate change and overcoming global poverty are the two defining challenges of the 21st century. The global responses to these challenges must be carefully designed, but if strong action is taken now, they will be both manageable and affordable.

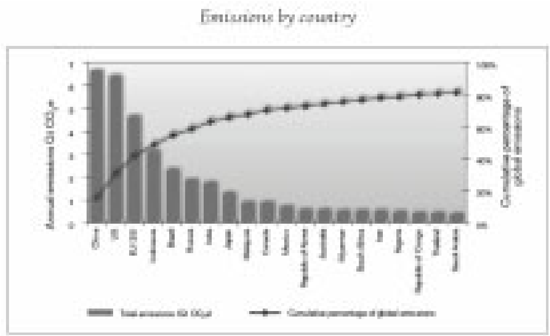
Rich countries are largely responsible for the causes of the current climate crisis, but it is developing countries that are being hit earliest and hardest by the consequences. Thus, rich countries must take strong action now and provide significant mitigation and adaptation assistance to developing countries. Developing countries must also play a leading role in designing and implementing a global deal. However, it is reasonable that developing countries place strong conditions on the performance of rich countries both in cutting their emissions drastically and in providing financial and technological support to developing country action; with such performance they could provide a "commitment to commit" to emissions reductions. Rich country support can and should start now with substantial help with finance for the climate change action plans which developing countries are now constructing.

I begin by briefly discussing the problem of climate change and what it implies for targets to reduce emissions of greenhouse gases. This leads to a discussion and analysis of how to achieve emissions targets and the likely costs involved. I conclude with the main elements that must be part of any global deal negotiated in Copenhagen in December 2009. If that global deal is to be built and sustained it must be effective, efficient and equitable.

From People to Emissions

The rate of growth of economic activity in the industrialising parts of the world accelerated dramatically from the mid-19th century onwards, while the form of that activity (the rise of industry and the relative decline of agriculture, for example) became much more hydrocarbon-intensive. These three effects-growth, industrialisation and hydrocarbon use-combined to increase greenhouse gas emissions. The second half of the 20th century saw a sharp increase in the rates of growth of emissions as the world recovered from the Great Depression and the Second World War, and more countries industrialised.

- The combined effects of growth, industrialisation and hydrocarbon use substantially increased flows of greenhouse gas emissions: thus concentrations of stocks have grown from 285ppm in the mid 19th-century to over 430ppm CO_2e today.

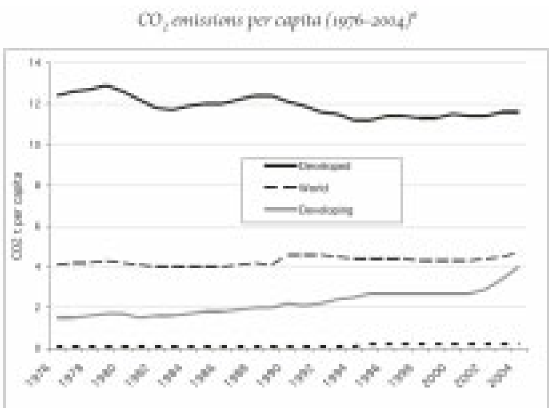


Source: Garnaut (2008), UNFCCC (2007) 2004 data for US, EU (25), Russia, Japan and Canada; Department of Climate Change (2008) 2004 data for Australia (using UNFCCC accounting); and World Resources Institute (2008) for other countries (2000 data except for CO_2 emissions from fossil fuels, which is for 2004).

Figure 1
From People to Emissions 1

- Over the next 20 years developing countries will play an increasing role in driving growth in overall emissions.

- Per capita emissions for rich countries are much higher.



Source: Climate Analysis Indicators Tool (CAIT)

Figure 2
From People to Emissions 2

From Emissions to Temperature

As a result of this hydrocarbon-intensive growth, the world has been emitting carbon dioxide and other greenhouse gases at a faster rate each year than the planet can absorb, especially during the rapid and energy-intensive growth of the last 60 years.

Concentrations of greenhouse gases in the atmosphere have grown from 285 parts per million (ppm) in pre-industrial times to over 435 ppm of carbon-dioxide-equivalent (CO_2e) today, and we are adding at a rate of over 2.5 ppm per year (and if there is little or weak action this is likely to accelerate to around 3 ppm per year or higher over the coming decades). As a result, continuing with 'business-as-usual' (BAU) is likely to take us to over 750 ppm CO_2e by the end of the century.[1]

This level of concentration, even if there were no further increase, would result in a significant probability, around 50% or more, of an eventual temperature increase of more than 5ºC compared with the pre-industrial era (our benchmark for temperature increases unless otherwise stated). The planet last experienced such temperatures more than 30 million years ago, long before the appearance of humans, 100 to 200,000 years ago. The most recent warm period was around 3 million years ago when the world experienced temperatures 2ºC or 3ºC higher than today. Humans have never experienced temperatures anywhere near a 5ºC increase.

From Temperature to Climate Change and Impacts on People

Thus 'business-as-usual' emissions of greenhouse gases would profoundly change the climate of the planet. Global sea level would rise by several metres and many low-lying coastal areas, such as much of Bangladesh, would be inundated. Many areas, probably including southern Europe would turn into deserts. The physical and thus human geography (where we can live and how we live our lives) would be transformed, leading to the migration of hundreds of millions of people, and intense competition for scarcer resources, such as water.[2] This would probably lead to intense and prolonged international and national conflicts. The stakes are immense: we are essentially gambling the planet.

The Fourth Assessment Report published by the Intergovernmental Panel on Climate Change (IPCC) in 2007 includes a review of recent research on the impacts of climate change in Japan. Average temperature in Japan increased by about 1ºC in the 20th century and by 2ºC to 3ºC in the largest cities. This is consistent with evidence of an increase in the number of days over 35ºC and a decrease in extremely low temperatures. There is also evidence of increased extreme rainfall events over the past 100 years, including serious flooding in 2004 which was the result of 10 typhoons. Migration of plants and animal species has also been reported, the flowering date of the cherry has changed and alpine flora in Hokkaido have decreased.

The IPCC also reports that heatwave conditions and extreme precipitation will increase over Japan as atmospheric moisture content increases. Significant decreases in rice production are also predicted; an atmosphere with carbon dioxide concentrations that are double those of pre-industrial times (i.e. around 560ppm CO_2e) could decrease rice yields in irrigated lowland areas of central and southern Japan by up to 40%. Sea level rise will also have powerful impacts on Japan. Over 4 million people could be at risk from a rise in sea level of 1 metre.

But remember that 'business-as-usual' will imply far higher concentrations than 550 or 560ppm CO_2e. The consequences for Japan both in terms of direct effects and migration of 550ppm CO_2e would be very unpleasant; for 650ppm CO_2e or more they are likely to be devastating.

Stabilisation level (in ppm CO_2e)	2°C	3°C	4°C	5°C	6°C	7°C
450	78	18	3	1	0	0
500	96	44	11	3	1	0
550	99	69	24	7	2	1
650	100	94	58	24	9	4
750	100	99	82	47	22	9

Extrapolations from Murphy et al. 2004

Source: Meinshausen 2006; Murphy et al. 2004; calculations.

- We are already over 430ppm CO_2e, and are adding at a rate of over 2.5ppm per year (likely to accelerate with little or weak action). BAU will take us over 750ppm by the end of the century.
- This level of concentration would result in a large probability, around 50% or more, of an eventual temperature increase of more than 5°C compared with the pre-industrial era. This would be enormously destructive.
- Physical and human geography would be transformed. The planet has not seen such temperatures for 30 million years. Potential cause of migration of billions of people around the world.

LSE

Figure 3
From Stocks to Temperature

What our Emissions Targets Should Be

In order to reduce the risk of climate change the world must act together and commit to targets for emissions reductions. Most assessments of sensible risk management imply that we should hold greenhouse gas concentrations at or below 500 ppm CO_2e, and try to reduce them from there. Holding concentrations below this level would expose the planet to a probability of global average temperature rising by 5ºC or more of around 2% or 3% compared with a huge 50% or more under 'business-as-usual'.

Looking longer term, we should recognise that holding concentrations below 500ppm CO_2e and bringing down to 450 ppm or below, would still carry a serious risk of passing a number of potential tipping points, like the destruction of rainforests and the release of methane from thawing permafrost. It makes sense, therefore, to interpret 'holding concentrations below 500 ppm' as eventually allowing a very long-term stabilisation markedly below that level. The learning we have to do to hold levels below 500 ppm will tell us much about how to go further. Just where around 500 ppm CO_2e, and then lower, we should aim is a matter of balancing the costs and the avoided risks. As the scientific evidence accumulates the risks look ever larger; on the other hand the technology of emissions reductions is already moving so quickly that costs of action and the benefits of new technologies may look even more attractive.

Annual global emissions of greenhouse gases were about 40 gigatonnes (Gt) CO_2e in 1990; they are over 50 today. If the world is to hold concentrations below 500ppm CO_2e and then try to reduce from there, then we must ensure annual global emissions peak within the next 10 years and reduce to half 1990 levels, or about 20 Gt CO_2e at most, by 2050. As the global population will probably be around 9 billion in 2050, this would be equivalent to emissions of around 2 tonnes CO_2e per capita. Given that there will be very few countries with actual emissions below this level there can be very few above.[3]

At the Italy summit (L'Aquila) in 2009, G8 leaders for the first time acknowledged the importance of avoiding an increase in global average temperature of more than 2ºC compared with pre-industrial times. They also agreed a goal for developed countries of reducing their annual emissions of greenhouse gases by at least 80% or more by 2050 compared with 1990. This would take actual emissions in Europe and Japan to around 2 tonnes per capita, the maximum sustainable for any major country as argued above.

In addition to these distant objectives, explicit intermediate targets for 2020 and 2030 are necessary now for the rich countries and very soon for all countries. The immediacy of the problem allows no delay, and businesses, markets and developing countries require strong signals now and powerful examples of what is possible. The longer we delay, the more difficult and more costly it will be to stay below 500 ppm CO_2e.

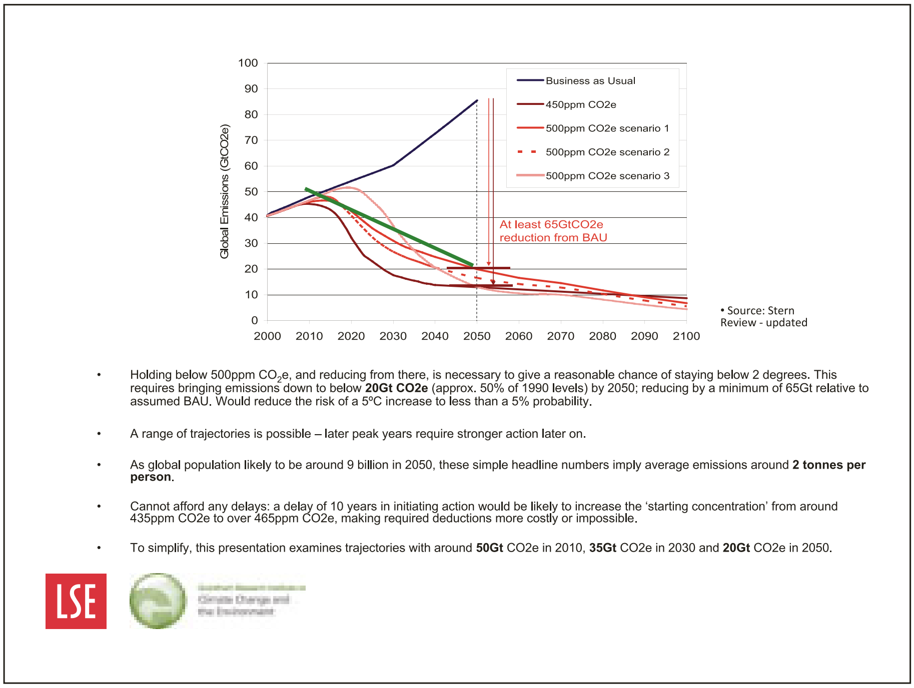


Figure 4
What our targets should be.

How to Achieve the Targets and Costs Involved

To be on a path to halve annual global emissions by 2050 from 1990, and allow eventual stabilisation at 450 ppm CO_2e, total world emissions in 2030 would have to be around 35 Gt CO_2e. Table 1 outlines six scenarios that demonstrate the extent of cuts necessary to achieve this interim 2030 target.

The scenarios focus on five nations or regional groups: USA, EU/Japan, China, India and the Rest of the World.[4] I have put the EU and Japan together since they start with similar emissions per capita and have similar emissions per unit of output. For all scenarios the overall economies grow at 2.5% for the USA and EU/Japan and 7% for each of China and India. The scenarios then look at different assumptions concerning emissions per unit of output. In the first block of 3 scenarios we have both the US and EU/Japan halving emissions per unit of output and in the second block, dividing by 4.

Within the blocks, the scenarios vary according to different assumptions concerning emissions per unit of output in India and China: India and China both constant; India constant and China halving; India halving and China dividing by 4. The assumptions concerning India relate to her much lower emissions per unit of output in 2010 (close to 2 tonnes versus around 6 for China) and to her lower standard of living (also her 'starting' emissions per unit of output are substantially lower than China's).

The table shows that only scenario 6 has any plausibility in terms of implications for the 4.3 billion people in the Rest of the World in 2030. Even that scenario would imply that the per capita emissions of the USA, EU/Japan and China would substantially exceed those of the 4.3 billion in the Rest of The World by 2030. Scenario 6 would require China to have peak emissions around 9 or 10 tonnes per capita with a peak around 2020 and India to peak at around 4 or 5 tonnes per capita well before 2030. Rich countries would have to reduce drastically starting now.

The architecture is clear: unless the USA, EU/Japan and China reduce emissions per unit of output by a factor of 4 it will not be possible to reach the goals that sensible risk management requires. The alternatives would be to cut growth or be reckless with the climate. Surely the right answer is to cut right back on emissions per unit of output. No major country, least of all a rich one, can claim to have good reason to 'contract out'. We must do this together.

Table 1: Emissions Scenarios Consistent with Global Emissions of 35 $GtCO_2e$ in 2030

Scenario for emissions (em) change to 2030	Emissions in 2030									
	USA		EU 27 & Japan		China		India		Rest of the World	
	tCO_2e per capita	Total ($GtCO_2e$)	tCO_2e per capita	Total ($GtCO_2e$)	tCO_2e per capita	Total ($GtCO_2e$)	tCO_2e per capita	Total ($GtCO_2e$)	tCO_2e per capita	Total ($GtCO_2e$)
Scenario 1: Overall growth: India & China 7%, US, EU27 & Japan 2.5%. em/output: India & China constant; US, EU27 & Japan halving.	16.6	6.2	9.9	6.2	20.8	31.3	5.3	7.9	-3.8	-16.5
Scenario 2: Overall growth: India & China 7%, US, EU27 & Japan 2.5%. em/output-India constant; China, US, EU27 & Japan halving.	16.6	6.2	9.9	6.2	10.4	15.6	5.3	7.9	-0.2	-0.9
Scenario 3: Overall growth: India & China 7%, US, EU27 & Japan 2.5%. em/output-India halving, China decrease by factor of 4; US, EU27 & Japan halving.	16.6	6.2	9.9	6.2	5.2	7.8	2.6	4.0	2.5	10.9
Scenario 4: Overall growth: India & China 7%, US, EU27 & Japan 2.5%. em/output: India & China constant; US, EU27 & Japan decrease by factor of 4.	8.3	3.1	4.9	3.1	20.8	31.3	5.3	7.9	-2.4	-10.3
Scenario 5: Overall growth: India & China 7%, US, EU27 & Japan 2.5%. em/output-India constant, China halving; US, EU27 & Japan decrease by factor of 4.	8.3	3.1	4.9	3.1	10.4	15.6	5.3	7.9	1.2	5.3
Scenario 6: Overall growth: India & China 7%, US, EU27 & Japan 2.5%. em/output-India halving; China, US, EU27 &Japan decrease by factor of 4.	8.3	3.1	4.9	3.1	5.2	7.8	2.6	4.0	4.0	17.1

Assumptions:	**Population (bn)**		**Emissions per capita (CO_2e)**	**Total emissions ($GtCO_2e$)**
	E2010	**E2030**	**E2010**	**E2010**
China	1.4	1.5	6.0	8.1
India	1.2	1.5	1.7	2.0
USA	0.3	0.4	25.1	7.5
EU27 & Japan	0.6	0.6	12.1	7.5
Rest of the World	3.4	4.3	7.8	26.8

Source: UN 2008 World Population Prospects

Sources: Climate Analysis Indicators Tool (CAIT) & Global Carbon Budget Project.

There will of course, be other countries such as the USA, Canada, Australia which must bring emissions down much more strongly than Japan or Europe-these 3 countries are currently well over 20 tonnes CO_2e per capita. In terms of technology and geography however Japan is much closer to Europe and the fact that others have still farther to go is no excuse for major and technologically advanced countries like Europe and Japan, and Japan is the world's second largest economy, to fail to take a strong lead. If a poor country like China, with much lower emissions per capita than Japan, is likely to have to cut emissions per unit of output by a factor around 4 in 20 years, it is hard to argue that Japan cannot also cut emissions per unit of output by a factor 4 and thus halve its per capita emissions to around 5 or 6 tonnes in the next two decades.

We should not be rigid about the precise figures for annual emissions in 2030 or any other particular year. There could be a little more emissions in one year and a little fewer in another. But the limits imposed by the overall arithmetic for total emissions over the next few decades are very real and give a very powerful indication of the scale of action required.

The key areas of actions to reduce emissions will be (i) energy efficiency (ii) low-carbon technologies and (iii) halting deforestation. All will require investments which will have to start strongly now across the world in order to achieve the annual emissions reductions required by 2030. At the start of the process of stabilising atmospheric concentrations there is great scope for energy efficiency improvements. *Energy efficiency* varies across developed countries. In 2005 Japan consumed 1.94 kWh of energy per dollar of GDP, expressed in (2000) USD. The EU consumed 2.29 kWh per dollar of GDP (there is significant variation within the EU from 4.4 kWh in Bulgaria to 1.33 kWh in Ireland). In contrast, the US consumed 2.68 kWh of energy per dollar of GDP in 2005. While Japan is more energy efficient than the US and some EU states, other major developed economies have achieved similar (Germany, France) or better (UK) levels of energy efficiency.

Developing and deploying low-carbon technologies and activities will also be essential, and Japan is in an excellent position to lead. Japan has shown great technological leadership in the past; the Toyota Prius is a prominent and important example of 'green' innovation and leadership by a Japanese company. Another, less well-known, example is the development and deployment of home-use fuel cells by Tokyo Gas Company and Panasonic Corporation. The success of these technologies, especially hybrid drive technology, demonstrates the rewards and opportunities available to those who lead.

The global emissions reductions necessary require there to be many more examples like these. We need a rapid and widespread advance in the development and diffusion of a wide range of technologies. Technology policy is essential to achieve this and is a powerful stimulus. Japan has great experience in this area of policy.

As with all policy that creates the incentives to drive major change, it is important to avoid overconcentration on the many lobbyists and vested interests that will seek to delay and/or reduce the effectiveness of policy. The world needs Japan's proven track record of technological innovation. Japan has a significant opportunity to lead the world again, just as she did with the development of the semi-conductor during the 20th century.

Halting deforestation will require major advance in agricultural productivity and in other parts of the economies of the regions where the trees stand. Governance and enforcement of laws on deforestation will require investment too. And peoples dependent on forests in various ways must have a strong and direct stake in their protection. Policies must be constructed by the countries where the trees stand but strong external support should be an obligation on us all. Japan is playing its role in helping to reduce deforestation. For example, it is an active participant in the Asia Forest Partnership (AFP) that aims to combat illegal logging and reduce forest loss and degradation. We all gain from avoided deforestation. We should be clear however that it will require substantial and sustained financial and other support.

The cost of stabilising at or below 450 ppm CO_2e (and implementing these different mitigation options), if the world acts now, is relatively small, compared to the cost of the damages avoided. Both the bottom-up and the top-down studies in the Stern Review, Chapters 9 and 10 respectively, arrived at mitigation costs in similar ranges-around 1% (between -1% and 3%) of world GDP for stabilisation below 550ppm CO_2e. With ever clearer evidence that risks from unmanaged climate change are even worse than was assumed by the Stern Review, it is clear that concentrations should be held below 500ppm CO_2e and eventually brought down to no higher than 450ppm CO_2e. The annual costs of mitigation over the next few decades might now be around 2% of world GDP.

Since the Stern Review was published there have been a number of new studies, both bottom-up and top-down. Significant examples of the former are those from McKinsey (Enkvist et al., 2007) and the IEA (2007), both of which indicated mitigation costs consistent with or lower than the Stern Review. Similar conclusions on costs of action are drawn in the Fourth Assessment Review of the IPCC (AR4, IPCC 2007).

These costs will mostly take the form of new investments and will appear, for a while, in terms of higher costs for energy to industrial and domestic consumers. But there will be potentially major savings from energy efficiency and the new low-carbon technologies, relative to those displaced, are likely to have strong benefits (energy security, cleaner air, less noise, etc.) beyond the reductions in emissions. Stopping deforestation carries great co-benefits too in terms of avoided soil erosion, silting and flooding and better watershed management, maintaining patterns of rainfall, bio-diversity and so on.

Thus, we should not see the route to the low-carbon economy merely or mostly in terms of cost and burden-sharing. There are investments and opportunities. The transition to the low-carbon economy over the next two or three decades is likely to be one of the most dynamic and exciting periods in economic history with strong discovery and growth. This will be wider and deeper in terms of technology and geography than the arrival of the railway and electricity in industrialising countries in the 19th and 20th centuries. And when low-carbon growth is achieved it will be more energy secure, cleaner, quieter, safer, and more bio-diverse than its predecessor; in other words much more attractive. High-carbon growth has no future: it will kill itself if we try to continue-first on high hydrocarbon prices and second and more fundamentally, on the very hostile physical environment it will create.

A Global Deal

The 15th Conference of the Parties (COP15) to the United Nations Framework Convention on Climate Change, to be held in Copenhagen in December 2009, will be decisive in determining the policies for the period beyond 2012 that succeed the Kyoto Protocol. The Copenhagen meeting will be the most important international gathering since the Second World War. The risks it must grapple with and the policies it agrees must be truly global. A delay in reaching an agreement would be dangerous. First, the relentless flow of emissions would continue to increase the stock of greenhouse gases in the atmosphere, taking us into ever more difficult territory and second, delay could undermine the market confidence that will be crucial for the necessary investments in the low-carbon economy.

It is important that the agreement in Copenhagen be guided by clear principles based on rigorous analytic foundations and a common understanding of the key challenges. The following provides a brief outline of a possible global deal based on the preceding analysis.[5] It also draws on intensive public discussion during the work of the Stern Review in 2005 and 2006 and on continual interaction internationally over the last three years.

Any global deal must be based on three basic principles:

Effectiveness-it must lead to cuts in emissions of greenhouse gases on the scale required to reduce the risks from climate change to acceptable levels;

Efficiency-it must be implemented in the most cost-effective way, with mitigation being undertaken where and when it is cheapest; and

Equity-it must take account of the fact that it is poor countries, with fewer resources and technologies, that are being hit earliest and hardest by the consequences of climate change, while rich countries have a particular responsibility for the cause through their past emissions.

Effectiveness

There are several requirements for 'effective' action:

- Global annual emissions to fall by at least 50% relative to 1990 levels by 2050, to at most 20 $GtCO_2e$;
- Global average per capita emissions that will need to be around two tonnes per year by 2050 (20 Gt divided by nine billion people);[6]
- Agreement by developed countries to take on immediate and binding national targets, and to commit to reductions of at least 80% by 2050 compared with 1990;
- Well before 2020, demonstration by developed countries that they can deliver credible reductions, without threatening growth, and that they can design mechanisms and institutions to transfer funds and technologies to developing countries;
- Subject to this and to strong support with finance and the sharing of technology, a formal expectation that developing countries would make a ‘commitment to commit’ to take on binding national targets of their own by 2020;

- All developing countries with or without immediate formal targets would require climate change action plans;
- A commitment by all countries, regardless of targets, to develop the institutions, data and monitoring capabilities to assess progress in a transparent way, and to put in place policies to avoid the locking-in of high-carbon infrastructure.

Efficiency

Only sound, measured and coordinated policy, and timely international collaboration, can deliver strong and clean growth for all at reasonable cost. The essence of efficiency is to get emissions reduced where the cost is lowest. If any mass sector, technology or country is left out, costs will rise. In principle, efficiency requires that the marginal cost of reducing emissions is the same everywhere.

Backed by very strong targets for cuts in emissions by developed countries, carbon prices can be maintained at levels which will provide incentives both for reductions at home and purchases from abroad, and will guide action towards the lowest cost options. The cheapest mitigation options often reside in developing countries, which should take advantage of carbon markets from the outset. The current structure of the Clean Development Mechanism (CDM) makes it difficult to create market flows to developing countries on the scale required. Moving from a project-based to a wholesale mechanism, perhaps based on sector-specific efficiency targets and credible sector decarbonisation plans, would permit scaling-up in a number of emissions and energy-intensive industries.

Equity

Any global response to climate change must be equitable; responsibilities and costs should be allocated in ways that take account of wealth, ability, and historical responsibility.

However, we start in a very difficult and inequitable position. The numbers are stark. Rich countries are responsible for around two-thirds of the existing stock of greenhouse gases in the atmosphere and their emissions per capita are much higher than those of poor countries. Therefore developing countries have a strong and understandable sense of injustice. They see rich countries having first relied on fossil fuels for their development, and thus being largely responsible for the existing stocks of greenhouse gases in the atmosphere, then telling developing countries to find another, and possibly more costly, route to development.

Given the inequities of the history of emissions, and the implications of climate change for future development, rich countries must demonstrate the feasibility of low-carbon growth and set an example for others. However, they should do much more than this. There is a strong imperative for the rich countries to provide more funds to developing countries, in addition to current development commitments, to fund the extra costs created by climate change.

Delivering additional funds on an appropriate scale is crucial. The long-standing target for development aid, set out in the Monterrey Consensus on Financing for Development in 2002 and reaffirmed in December 2008 in the Doha Declaration on Financing for Development, is for developed countries to provide at least 0.7% of GNP as Official Development Assistance (ODA). The EU gave itself, in June 2005, just before the G8 meeting at Gleneagles in the UK, until 2015 to reach the target.

Adaptation to a more hostile climate, however responsible we are in cutting emissions, will increase the burden on developing governments. Therefore the targets for support from the public budgets of rich countries are likely to be closer to 1.0% of GNP than 0.7% for the coming two decades. With the private flows that could come with them and the growth and poverty reduction they could help foster, these flows of public funds would constitute very wise investments for the world as a whole, as well as the fulfilment of our duty as citizens of the world.

Developing countries should challenge the rich countries to commit to very strong cuts in emissions. They could place the following conditions on rich countries and, on condition of their fulfilment, the developing world should give a 'commitment to commit' to targets within 5-10 years:

(i) strong performance by the rich countries over the next decade towards meeting targets for 2020, 2025 and 2030, which are tough and fully consistent with a path to reductions in emissions of at least 80% by 2050 relative to 1990;

(ii) financial support through the markets and elsewhere for action in the developing world, and strong support in the battle against deforestation; by the 2020s the necessary flows to support reductions in emissions by developing countries are likely to be in the region of \$100bn per annum.[7]

(iii) rich countries to develop new technologies for low-carbon economic growth, which should be shared with developing countries; and

(iv) substantial assistance in adaptation to those impacts of climate change which are now inevitable over the next few decades; by the 2020s the necessary additional support (over and above existing ODA countries) is likely to be in the region of \$100bn per annum.[8]

This would be a framework where the developing world would explain to the rich world what is necessary and place the conditionality and performance requirements on them.

Conclusion

If the world allows climate responsibility on the one hand, and growth, development and the fight against world poverty, on the other, to become set against each other, the argument is lost from the start. The world has both the technology and the economic understanding to move forward strongly on both simultaneously. In other words the two defining challenges of our century must be tackled together. If we fail to manage climate change we will derail development and if we try to manage climate change by blocking development we will fail to build the global coalition necessary to reduce emissions.

Japan is in a strong position be in the vanguard on climate change. Japan has an enviable track record of leadership in technological innovation and the world looks to Japan to again demonstrate this leadership. Strong and effective climate change policy that sets a clear and instructive example for the rest of the world is crucial. If not the world will ask "if a country like Japan cannot do this, then how can we?" Japan is pivotal.

At Copenhagen in December 2009, leadership must come from the top; that means heads of government. The problems of climate change are too wide to be confined only to one or two individual government departments, ministries or negotiators. It is vital that united and decisive leadership is displayed by heads of government. And if we learn to collaborate on the necessary scale in this fundamental area we will surely do much better in the many other important areas of international policy.

Rich countries must recognise their responsibilities, especially to developing countries and take strong action now. Developing countries should place conditions on rich countries, and on condition of their fulfilment, 'commit to commit' to substantial cuts in emissions of their own. The arithmetic is crystal clear, only a comprehensive agreement that involves both rich and developing countries can achieve the cuts in emissions necessary to avoid dangerous climate change.

Action is not led only from the top: it will be the individual understanding of citizens, communities, companies and NGOs that will drive forward this debate. The understanding and demands of members of the public are the most fundamental drivers of political change. It will be this voice that will carry us through to a more responsible future.

Notes

1. For references the reader may wish to consult my recent book "A Blueprint for a Safer Planet", published by Bodley Head in April 2009 (title in the USA is "A Global Deal" and published by Public Affairs), the Stern Review on "The Economics of Climate Change" published by Cambridge University Press in January 2007, or the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).
2. Note that the effects of climate change operate mostly through water in some shape or form: storms, floods, drought, sea-level rise.
3. The base of 1990 for emissions reductions is not always stated-but it should be. The 20 Gt CO_2e upper limit in 2050 already involves substantial risk and should not be revised upwards.
4. EU refers to the 27 member countries of the European Union.
5. The reader may wish to consult my recent book "A Blueprint for a Safer Planet", for a detailed description.
6. We should note that this applies to actual emissions and there are strong arguments for rich countries to not only limit their actual emissions to these levels but also to fund emissions reductions elsewhere.
7. See, for example, "A Blueprint for a Safer Planet", Stern, 2009.
8. See, for example, the analysis of the Human Development Report 2007-08 which indicated costs around $85bn p.a. by 2015.

Major Publications

Lord (Nicholas) Stern of Brentford

Books

An Appraisal of Tea Production on Smallholdings in Kenya, published by the OECD, Paris, January 1972.

Theories of Economic Growth, edited with J.A. Mirrlees. Proceedings of a conference of the International Economic Association in Jerusalem, April 1970), Macmillan, 1973.

Crime, The Police and Criminal Statistics (with R.A. Carr-Hill), Academic Press, May 1979.

Palanpur: The Economy of an Indian Village (with C.J. Bliss), Oxford University Press, 1982.

The Theory of Taxation for Developing Countries (edited with D.M.G. Newbery), (Chapter 1, with D. Newbery), (Chapter 2), (Chapter 3), (Chapter 5 with D. Newbery), (Chapter 11, with E. Ahmad), (Chapter 25, with D. Newbery), World Bank and Oxford University Press, 1987.

The Theory and Practice of Tax Reform in Developing Countries (with E. Ahmad), Cambridge University Press, 1991.

Development Experiences in China and India: Reforms and Modernisation (edited with S.P. Gupta, A. Hussain and W. Byrd), Allied Publishers, Delhi, 1991.

Le Rôle de l'Etat dans le Développement Économique, Editions Payot, Lausanne, 1992. The first annual Conférence Walras-Pareto delivered at the University of Lausanne, 1-3 May 1991.

Tax Policy and Planning in Developing Countries (with Amaresh Bagchi), Oxford University Press, Delhi, 1991.

Development Experiences in China and India (ed with S.P.Gupta, A,Hussain and W.Byrd), Allied, Delhi, 1991.

Editor of the Transition Report (the EBRD's main annual publication) and the Transition Report Update from 1994-1999.

Growth Theories Old and New, and the Role of Agriculture in Economic Development, FAO, Rome 1996.

Development Strategy and Management of the Market Economy, Volume I, (with Malinvaud *et al.*), 1997.

Economic Development in Palanpur over Five Decades (with Peter Lanjouw), Oxford University Press, 1998.

A Strategy for Development, The World Bank, 2002.

A Case for Aid (with Ian Goldin and Halsey Rogers), the World Bank 2002.

State-level Reforms in India, (ed. with Stephen Howes and Ashok Lahiri), Macmillan, Delhi, 2003.

Growth and Empowerment, Making Development Happen, (with Jean-Jacques Dethier and F. Halsey Rogers), MIT Press, 2005.

Our Common Interest, Report of the Commission for Africa, (as Director of Policy and Research) Commission for Africa, 2005.

Economics of Climate Change, Cambridge University Press, 2007.

A Blueprint for a Safer Planet: how to manage climate change and create a new era of progress and prosperity, London: The Bodley Head, 2009 (Also printed as A Global Deal: climate change and the creation of a new era of progress and prosperity, New York: Public Affairs, 2009.

Articles/Book Chapters

On Fairly Good Plans (with J.A. Mirrlees), Journal of Economic Theory, 4, 268-288, April 1972.

Optimum Development in a Dual Economy, Review of Economic Studies, 39, 171-184, April 1972.

The Optimal Size of Market Areas, Journal of Economic Theory, 2, 4, 154-173, April 1972.

The Optimal Structure of Market Areas (with B. Bollobas), Journal of Economic Theory, 4, 174-179, April 1972.

Experience With the Use of the Little/Mirrlees Method for an Appraisal of Smallholder Tea in Kenya, Bulletin of the Oxford University Institute of Economics and Statistics, 34, 93-123, April 1972.

Delinquent Generations Revisited (with R.A. Carr-Hill and K. Hope), The European Journal of Methodology: Quality and Quantity, 2, 327-352, 1972.

An Econometric Model of the Supply and Control of Recorded Offences in England and Wales (with R.A. Carr-Hill), Journal of Public Economics, 2, 289-318, 1973.

Homogeneous Utility Functions and Equality in 'The Optimum Town': A Note, The Swedish Journal of Economics, 2, 1973.

Pigou, Taxation and Public Goods (with A.B. Atkinson), Review of Economic Studies, 41, 119-128, January 1974.

Determinants of Shadow Prices in Open Dual Economies (with A.K. Dixit), Oxford Economic Papers, 26, 42-53,

March 1974.
Professor Bauer on Development: A Review Article, Journal of Development Economics, 1, 191-211, 1974.
Optimum Savings with Economies of Scale (with A.K. Dixit and J.A. Mirrlees), Review of Economic Studies, 42, 303-325, July 1974.
Some Aspects of the Theory of Economic Policy, paper delivered to a conference of the Institute of Mathematics and its Applications, June 1974, published in the Journal of the I.M.A. in 1975.
On the Specification of Models of Optimum Income Taxation, presented to conference of International Seminar in Public Economics in Paris in January 1975 and published in the Journal of Public Economics, 6, 123-162, July/August 1985.
Welfare Weights and the Elasticity of the Marginal Valuation of Income. Published as Chapter 8 in Proceedings of the AUTE Edinburgh Meeting of April 1976, M. Artis and R. Nobay (eds.), Basil Blackwell, 1977.
Theory and Estimation in Models of Crime and its Social Control and their Relations to Concepts of Social Output (with R.A. Carr-Hill), presented to the International Economic Association Conference on The Economics of the Public Services, in Turin, April 1974 and published (Chapter 6) by MacMillan for the IEA, Feldstein and Inman (eds.), 1976.
Taxation and Labour Supply—A Partial Survey, presented to the Institute for Fiscal Studies Conference on Taxation and Incentives, January 1976 and published by the IFS, 1976.
Productivity, Wages and Nutrition: Part I Theory, (with C.J. Bliss), Journal of Development Economics, 5, 331-362, December 1978.
Productivity, Wages and Nutrition: Part II Some Observations (with C.J. Bliss), Journal of Development Economics, 5, 363-398, December 1978.
On the Economic Theory of Policy Towards Crime, Chapter 4 in J.M. Heineke (ed.), Economic Models of Criminal Behaviour, North-Holland, 1978.
A Note on the Allocation of Time (with A.B. Atkinson), Economics Letters, 3, 119-123, 1979.
On the Switch from Direct to Indirect Taxation (with A.B. Atkinson and J. Gomulka), Journal of Public Economics, 14(2), 195-224, 1980.
Productivity, Wages and Nutrition in the Context of Less Developed Countries (with C.J. Bliss), Study in Population and Agricultural Development, No.7, FAO, Rome 1978. French translation in Cahiers du Seminaire d' Econometrie, publiés sous la direction de Edmond Malinvaud, 21, 101-122, 1980.
On Labour Supply and Commodity Demands (with A.B. Atkinson in conjunction with J. Gomulka), Chapter 10 in Essays in the Theory and Measurement of Consumer Behaviour, A.S. Deaton (ed.), Cambridge University Press, 1981.
Optimum Taxation with Errors in Administration, Journal of Public Economics, 2, 181-211, March 1982.
Oligopoly and Welfare (with A.K. Dixit), European Economic Review, 19(1), 123-143, 1982.
Taxation for Efficiency, in Microeconomic Efficiency and Macroeconomic Performance, D. Shepherd, J. Turk and A. Silberston (eds.), Philip Allan, 1983.
Crime and the Dole Queue (with R.A. Carr-Hill), Police, pp. 28-32, April 1983.
Unemployment and Crime: A Comment on 'The Social Consequences of High Unemployment' (with R.A. Carr-Hill), Journal of Social Policy, 12(3), 387-394, 1983.
The Structure of Personal Income Taxation and Income Support (with A.B. Atkinson and M.A. King), SSRC Programme on Taxation, Incentives and the Distribution of Income, Discussion Paper No.44, published as evidence in the third special report of the House of Commons Treasury and Civil Service Committee HC (1982-83), 386, June 1983.
Tax Reform: Income Distribution, Government Revenue and Planning, the V.K. Ramaswami Memorial Lecture delivered in Delhi in March 1983, published in the Indian Economic Review, 18(1), 17-33, 1983.
Optimum Taxation and Tax Policy, IMF Staff Papers, 31(2), 339-378, June 1984.
The Theory of Reform and Indian Indirect Taxes (with E. Ahmad), Journal of Public Economics, 25(3), 259-295, December 1984.
The Poverty Trap (with A.B. Atkinson), Economic Review, 12(5), May 1985.
A Note on Commodity Taxation: The Choice of Variable and the Slutsky, Hessian and Antonelli Matrices (SHAM), Review of Economic Studies, 53, 293-299, April 1986.
On the Specification of Labour Supply Functions, ESRC, Programme on Taxation, Incentives and the Distribution of Income, Discussion Paper No.50, and published in Unemployment, Search and Labour Supply, R. Blundell and I. Walker (eds.) (Chapter 9), Cambridge University Press, 1986.

Tax Reform for Pakistan: Overview and Effective Taxes for 1975-76 (with E. Ahmad), Pakistan Development Review, 25(1), 43-72, Spring 1986.
Optimally Uniform Commodity Taxes, Taste Differences and Lump-sum Grants (with A.S. Deaton), Economics Letters, 20, 263-266, March 1986.
The Effects of Taxation, Price Control and Government Contracts in Oligopoly and Monopolistic Competi-tion, Journal of Public Economics, 32, 133-158, March 1987.
The Theory of Cost-Benefit Analysis (with J. Drèze), in Handbook of Public Economics, A. Auerbach and M. Feldstein (eds.), North-Holland 1987.
The Demand for Wheat under Non-Linear Pricing in Pakistan (with E. Ahmad and H-M Leung), Journal of Econometrics, 36, pp.55-65, September 1987.
Entry on Peasant Economy, in The New Palgrave: A Dictionary of Economics, J. Eatwell, M. Milgate and P. Newman (eds.), Macmillan Press, September 1987.
Optimum Taxation, in The New Palgrave: A Dictionary of Economics, J. Eatwell, M. Milgate and P. Newman (eds.), Macmillan Press, September 1987.
Alcohol: Demand and Taxation under Monopoly and Oligopoly in South India in the 1970s (with S. Musgrave), Journal of Development Economics, 28, 1-41, February 1988.
Comparison of the FES and New Earnings Survey 1971-77 (with A.B. Atkinson and J. Micklewright), in Tax Benefit Models, A.B. Atkinson and H. Sutherland (eds.), STICERD Occasional Paper 10, London School of Economics, 1988.
A Complete Set of Shadow Prices for Pakistan: Illustrations for 1975-76 (with E. Ahmad and D. Coady), Pakistan Development Review, 27(1), 7-43, Spring 1988.
Demand Response in Pakistan: A Modification of the Linear Expenditure System for 1976 with (E. Ahmad and S. Ludlow), Pakistan Development Review, 27(3), 293-308, Autumn 1988.
The Economics of Development: A Survey, Economic Journal, 99, 597-685, September 1989. Also published in Surveys in Economics: Volume 2, A.J. Oswald (ed.), Blackwell, 1991.
The Poverty Trap in Britain with (A.B. Atkinson and M.A. King), in Poverty and Social Security, A.B. Atkinson (ed.), Harvester Wheatsheaf, 1989.
Taxation for Developing Countries (with E. Ahmad), in Handbook of Development Economics, Volume II, H.B. Chenery and T. N. Srinivasan (eds.), North Holland, 1989.
Comment on 'Social Sector Pricing Policy Revisited' by E. Jimenez, Proceedings of the World Bank Conference on Development Economics 1989, pp.143-147, (Supplement to The World Bank Economic Review and The World Bank Research Observer), World Bank, Washington, D.C., 1990.
Uniformity versus Selectivity in Indirect Taxation, Economics and Politics, 2(1), 83-108, March 1990.
Tax Reform and Shadow Prices for Pakistan (with E. Ahmad), Oxford Economic Papers, 42, 135-159, 1990. Also published in Taxation, Private Information and Capital, P.J.N. Sinclair and M.D.E. Slater (eds.), Oxford: Clarendon Press, 1991.
Principles of Taxation for Developing Countries (with E. Ahmad) in Public Policy and Economic Development: Essays in Honour of Ian Little, M.FG. Scott and D. Lal (eds.), Oxford University Press, 1990.
Comments for the Closing Panel presented at the World Bank Conference on Tax Policy in Developing Countries, Washington, DC, March 1990, in Tax Policy in Developing Countries, Javed Khalilzadah-Shirazi and Anwar Shah (eds.), The World Bank, Washington, D.C.
How Should Ignorance of Response to Incentives Affect Tax Rates?, Economics Letters, 32(4), 335-338, April 1990.
The Employment of Married Women in the UK; 1970-1983 (with J. Gomulka), Economica, 57, 171-199, May 1990.
Policy Reform, Shadow Prices and Market Prices (with J. Drèze), Journal of Public Economics, 42, 1-46, June 1990.
Spending on Alcohol—Evidence from the Family Expenditure Survey 1970-1983 (with A.B. Atkinson and J. Gomulka), Economic Journal, 100, 808-827, September 1990.
Roundtable Discussion on Development Strategies: The Roles of the State and the Private Sector, Proceedings of the World Bank Annual Conference on Development Economics 1990, pp.425-429 (Supplement to the The World Bank Economic Review and The World Bank Research Observer, The World Bank, Washington, D.C., 1991.
Social Security in Developing Countries: What, Why, Who and How? (with R. Burgess), in Social Security in

Developing Countries, E. Ahmad, J. Drèze, A.K. Sen, and J. Hills (eds.), Oxford University Press, 1991.
Poverty in Palanpur (with P. Lanjouw), The World Bank Economic Review, 5, 23-33, January 1991.
The Determinants of Growth, Economic Journal, 101, 404, January 1991. Also published in The Future of Economics, John D. Hey (ed.), Basil Blackwell, 1992.
Prices, Taxes and Planning, Ricerche Economiche, 44, 303-320, April 1991.
Effective Demand, Enterprise Reforms and Public Finance in China (with A. Hussain), Economic Policy, 12, 141-186, April 1991.
Public Policy and the Economics of Development (The Alfred Marshall Lecture, 31 August 1990, Lisbon), European Economic Review, 35, 241-271, April 1991.
On the Recent Increase in Death Rates in China (with A. Hussain), in Development Experience in India and China, S.P. Gupta, N. Stern, A. Hussain and W. Byrd (eds.), Allied Publishers, New Delhi 1991.
Project Appraisal and Development Policy, Rivista di Diritto Finanziario e Scienza Delle Finanze, 645-656, December 1991.
From the Static to the Dynamic: Some Problems in the Theory of Taxation, Journal of Public Economics (Special Issue: ISPE/NIPFP Conference on Taxation and Planning), 47(2), 273-297, March 1992.
Discussion on 'Structural Factors and Tax Revenue in Developing Countries: A Decade of Evidence', by Vito Tanzi, pp.286-289 in Open Economies: Structural Adjustment and Agriculture, Ian Goldin and L. Alan Winters (eds.), Cambridge University Press, 1992.
Economic Reforms and Public Finance in China (with Athar Hussain), Public Finance, 47 (supplement), 289-317, 1992.
The Role of the State, Ownership and Taxation in Transitional Economies (with Athar Hussain), Economics of Transition 1(1), 61-87, 1993.
Comment on 'James Meade and Benevolence' by Frank Hahn, pp.264-268 in A.B. Atkinson (ed), Alternatives to Capitalism: the Economics of Partnership (Proceedings of a conference held in September 1991, in honour of James Meade by the International Economic Association at Windsor), Macmillan/St Martin's Press, 1993.
Taxation and Development (with Robin Burgess), Journal of Economic Literature, 31, 762-830, June, 1993.
Tax Reform in India (with Robin Burgess), Indian Journal of Applied Economics, 3, pp.1-81, 1994.
The Reform of Indirect Taxes in India (with Robin Burgess and Stephen Howes), pp.113-166 in Robert Cassen and Vijay Joshi (eds), India: The Future of Economic Reform, Delhi: Oxford University Press, 1995.
Value-Added Tax Options for India (with Robin Burgess and Stephen Howes), International Tax and Public Finance, Vol.2, No.1, pp.109-141, May 1995.
Transition Report, in an annual series by the Chief Economist's Office, EBRD, November 1994, 1995, 1996, 1997, 1998, 1999.
Transition Report Update, Chief Economist's Office, EBRD, April 1995, 1996, 1997, 1998, 1999.
Tax Reform and Stabilisation in Sri Lanka in Mario I. Blejer and Teresa Ter-Minassian (eds), Macroeconomic Dimensions of Public Finance: Essays in honour of Vito Tanzi, pp.413-439, London: Routledge, 1997.
The Transition in Eastern Europe and the Former Soviet Union: Some Strategic Lessons from the Experience of 25 Countries Over Six Years in Salvatore Zecchini (ed) Lessons from the Economic Transition: Central and Eastern Europe in the 1990s, pp.35-57, Kluwer Academic Publishers for OECD, Paris, 1997.
Enterprise Performance and Macroeconomic Control (with W. Buiter and R. Lago), Banco Nazionale del Lavoro Quarterly Review, Vol.50, No.200, pp.3-22, March 1997.
Macroeconomic Policy and the Role of the State in a Changing World in Malinvaud, E. *et al* (eds) Development Strategy and Management of the Market Economy Volume I, pp.143-174, Oxford: Clarendon Press (for the United Nations, New York), 1997.
A Framework for a Development Strategy in a Market Economy (with J.E. Stiglitz), in Malinvaud, E. *et al* (eds) Development Strategy and Management of the Market Economy Volume I, pp.253-296, Oxford: Clarendon Press (for the United Nations, New York), 1997.
The World Bank as 'Intellectual Actor' (with Francisco Ferreira), in D. Kapur, J.P. Lewis and R. Webb (eds) The World Bank: Its First Half Century, Volume 2: Perspectives, pp.523-609, Washington, D.C.: The Brookings Institution, 1997.
Promoting an Effective Market Economy in a Changing World (with Willem Buiter and Ricardo Lago), in Szekely, I.P. and Sabot, R. (eds) Development Strategy and Management of the Market Economy Volume II, pp.11-90, Oxford: Clarendon Press (for the United Nations, New York), 1997.
A Stress Test for the East, The Banker, pp. 18-21, July 1998.

Making the Most of Markets (with Hans Peter Lankes), EIB Papers 40th Anniversary Issue, Vol.3, No.2, 1998.
Macroeconomic Progress (with Marina Wes), in Ministry of Economic Affairs of the Netherlands, The Second Decade: Prospects for European Integration after Ten Years of Transition, pp.19-47, The Hague: Sdu Publishers, 1999.
Capital Flows to Eastern Europe and the Former Soviet Union (with Hans Peter Lankes), in Feldstein, M. (ed), International Capital Flows, pp.57-97, Chicago and London: University of Chicago Press, 1999.
Broadening the Agenda for Poverty Reduction: Opportunity, Empowerment, Security (with Nora Lustig), Finance & Development, Vol. 37, Issue 4, December 2000.
Cinquante ans de développement économique: bilan et experiences (with P. Collier and D. Dollar), Revue Economique du Développement, No. 1-2, pp. 23-64, 2001.
Towards a Dynamic Public Economics, Journal of Public Economics, September 2001.
Opportunities off the Farm as a Springboard out of Rural Poverty: Five Decades of Development in Indian Village, (with P. Lanjouw) in ed G.Fields and G.Pfeffermann. Pathways Out of Poverty: Private Firms and Economic Mobility in Developing Countries, Kluwer,Boston, 2003.
Public Policy for Growth and Poverty Reduction, The Economic Quarterly, Vol. 50, No. 1, March 2003.
Growth and Poverty Reduction, CESifo Economic Studies, Vol. 49, No. 1/2003.
Investment Climate: Lessons and Challenges, Distinguished Lecture Series 19, The Egyptian Center for Economic Studies, March 2003.
The Future of the IMF and World Bank: Panel Discussion, The American Economic Review, May 2003.
Agricultural Changes and Inequality in Palanpur 1957-1984 (with P. Lanjouw), K. Hoff, A. Braverman and J. E. Stiglitz (Eds), The Economics of Rural Organisation: Theory, practice, and policy, Oxford; New York; Toronto and Melbourne: Oxford University Press for the World Bank (1993).
Policies for Pro-Poor Growth in India (with M. Ferro and D. Rosenblatt), in ed K.Basu, India's Emerging Economy, MIT Press, 2004.
Evaluating the poverty impact on economic policies: some analytical challenges (with F.Bourguignon and L. Pereira da Silva) in eds Ashoka Mody and Catherine Pattillo, Macroeconomic Policies and Poverty Reduction, Routledge, for IMF, Abingdon and New York, 2006.
Making Development work in Africa: Our Common Interest Economie publique, No 17. May 2006.
Supporting and financing Africa's resurgence, Journal of African Economics, Journal pf African Economies, Volume 15, Supplement 2: 2006.
Reflections on the Stern Review: a robust case for strong action to reduce the risks of climate change (with Simon Dietz, Chris Hope and Dimitri Zenghelis), World Economics, Vol.8, No.1 (January-March) 2007.
Right for the Right Reasons: a final rejoinder on the Stern Review (with Dennis Anderson, Simon Dietz, Chris Hope and Demitri Zenghelis), World Economics, Vol.8, No.2 (April-June) 2007.
A new global deal on climate change (with Cameron Hepburn), Oxford Review of Economic Policy, 24 (2), 259-270, 2008.
Climate Change, Ethics and the Economics of the Global Deal, Royal Economic Society Annual Lectures (Manchester, 29 November 2007/London, 30 November 2007).
The Economics of Climate Change, Richard T. Ely Lecture, American Economic Association Annual Meeting, New Orleans, 4 January 2008, American Economic Review: Papers and Proceedings 2008, Vol. 98. No.2, pp.1-37.
Climate Change Innovation and Jobs (with Samuel Fankhauser and Friedel Sehlleier), Climate Policy Vol. 8. pp.421-429, 2008.
Why economic analysis supports strong action on climate change: a response to the Stern Review's critics (with Simon Dietz), Review of Environmental Economics and Policy, Vol. 2. Issue 1. pp.94-113, 2008.
Economics, ethics and climate change (with Simon Dietz and Cameron Hepburn), in Kaushik Basu and Ravi Kanbur (eds.) Arguments for a Better World: Essays in Honour of Amartya Sen (Volume 2: Society, Institutions and Development), Oxford: Oxford University Press, 2009.
Changing Economics in Felix Dodds, Andrew Higham and Richard Sherman (eds.) Climate Change and Energy Insecurity: The Challenge for Peace, Security and Development, Earthscan, London, 2009.
On the timing of greenhouse gas emissions reductions: a final rejoinder to the symposium on, The Economics of Climate Change: The Stern Review and its Critics (with Simon Dietz), Review of Environmental Economics and Policy, Vol. 3. Issue 1. pp.138-140, 2009.
The Global Deal on Climate Change (with Cameron Hepburn), in Dieter Helm and Cameron Hepburn (eds.) The

Economics and Politics of Climate Change, Oxford: Oxford University Press, 36-57, 2009.
Roundtable Discussion: Economics and climate change: where do we stand and where do we go from here? contributor to chapter in Jean-Philippe Touffut (ed) Changing Climate, Changing Economy, (proceedings from the Centre Cournot conference, December 2008), Edward Elgar, 2009.
Environmental Policy and the Economic Downturn, (with Alex Bowen) Oxford Review of Economic Policy, 26 (2): 137-163, 2010.
The Economics of Climate Change, in Stephen M. Gardiner, Simon Caney, Dale Jamieson, and Henry Shue (eds.) Climate Ethics: Essential Readings, Oxford: Oxford University Press, 2010.
Imperfections In The Economics Of Public Policy, Imperfections In Markets, And Climate Change, Presidential Address, European Economic Association, Journal of the European Economic Association, Vol. 8. Issue 2-3. pp.253-288, 2010.
Gérer les changements climatiques: climat, croissance, développement et équité, Leçons Inaugurales du Collège de France. Collège de France/Fayard, 23 June 2010.
Climate: What You Need to Know, The New York Review of Books, 24 June 2010.
Climate change and India (with Ruth Kattumuri and Nandan Nilekani), in Shankar Acharya, Rakesh Mohan (eds.) India's Economy: Performance and Challenges Essays in Honour of Montek Singh Ahluwalia, Oxford: Oxford University Press, 2010.
Commentary (with Paul Johnson) on Environmental Taxes by Don Fullerton, Andrew Leicester, and Stephen Smith, in Stuart Adam, Timothy Besley, Richard Blundell, Stephen Bond, Robert Chote, Malcolm Gammie, Paul Johnson, Gareth Myles, and James Poterba (eds) Dimensions of Tax Design: The Mirrlees Review, New York: Oxford University Press for the Institute for Fiscal Studies, 2010.
Uncertainty in Science and its Role in Climate Policy (with Leonard Smith), Philosophical Transactions of the Royal Society A, 369, 1-24, 2011.
Sustainable healthcare needs interdisciplinary research: Interdisciplinary collaboration is needed to ensure we develop future proof models of care (with Anita Charlesworth, Alastair Gray, David Pencheon), British Medical Journal, October 2011.
The New Energy-industrial Revolution and International Agreement on Climate Change (with James Rydge), Economics of Energy and Environmental Policy, 1(1): 1-19, forthcoming, 2012.
Raising Consumption, Maintaining Growth and Reducing Emissions: The objectives and challenges of China's radical change in strategy and its implications for the world economy, World Economics, forthcoming, 2012.
Low-carbon Growth and Development, (with Ruth Kattumuri and James Rydge) Oxford Companion to Economics in India, pp.210-317, Oxford University Press, forthcoming, 2012.

The Blue Planet Prize recognises outstanding efforts in scientific research or applications of science that contribute to solving global environmental problems. The prize was created by the Asahi Glass Foundation in 1992, the year of the Rio Earth Summit, and since then the foundation has awarded the prize to two winners every year.[1] In 2012, twenty of the Blue Planet Prize winners collaborated on a joint paper that was launched at the UN Environment Programme's Governing Council meeting in Nairobi on 20. The Blue Planet Prize recognises outstanding efforts in scientific research or applications of science that contribute to solving global environmental problems.Â Lester Russel Brown is a United States environmental analyst, founder of the Worldwatch Institute, and founder and former president of the Earth Policy Institute, a nonprofit research organization based in Washington, D.C. BBC Radio commentator Peter Day referred to him as â€¦ Full Planet, Empty Plates (2012). The Great Transition (2015). Image: Lester Brown.