Centre for Climate Change Economics and Policy

Grantham Research Institute on Climate Change and the Environment

Recklessly slow or a rapid transition to a low-carbon economy? Time to decide

Mattia Romani, James Rydge and Nicholas Stern

Policy paper

December 2012

Centre for Climate Change Economics and Policy

Grantham Research Institute on Climate Change and the Environment

The Grantham Foundation for the Protection of the Environment

Global Green Growth Institute

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

Munich RE

University of Leeds

LSE The London School of Economics and Political Science

The Centre for Climate Change Economics and Policy (CCCEP) was established in 2008 to advance public and private action on climate change through rigorous, innovative research. The Centre is hosted jointly by the University of Leeds and the London School of Economics and Political Science. It is funded by the UK Economic and Social Research Council and Munich Re. More information about the Centre for Climate Change Economics and Policy can be found at: http://www.cccep.ac.uk

The Grantham Research Institute on Climate Change and the Environment was established in 2008 at the London School of Economics and Political Science. The Institute brings together international expertise on economics, as well as finance, geography, the environment, international development and political economy to establish a world-leading centre for policy-relevant research, teaching and training in climate change and the environment. It is funded by the Grantham Foundation for the Protection of the Environment, which also funds the Grantham Institute for Climate Change at Imperial College London, and the Global Green Growth Institute. More information about the Grantham Research Institute can be found at: http://www.lse.ac.uk/grantham/

Recklessly slow or a rapid transition to a low-carbon economy? Time to decide

Executive Summary

- The world is heading in a difficult and dangerous direction. A range of estimates based on current plans and intentions arrive at similar conclusions: at best, global emissions will plateau at around 50 billion tonnes of carbon-dioxide-equivalent per year over the coming decades, with a strong possibility they will go much higher. The scale of the risks from these levels of emissions is immense, with likely changes in climate way beyond the experience of modern civilisation.
- The overall pace of change is recklessly slow. We are acting as if change is too difficult and costly and delay is not a problem. The rigidity of the processes under the United Nations Framework Convention on Climate Change and the behaviour of participants also hinder progress. And the vested interests remain powerful.
- Despite the slow overall pace of change, there are strong signs of activity and creativity across the world. And we have learned much over the past decade about the scale of the risks, the technologies required and the economics. Accelerating the pace of change towards a low-carbon, resource-efficient economy is both feasible and crucial; with the right incentives rapid transformative change is possible, even in capital-intensive sectors such as energy.
- The alternative low-carbon, more resource-efficient path is likely to be full of discovery and attractive in terms of environment, security, health and community; far more attractive than high-carbon business-as-usual. As the transition accelerates, high-carbon, resource-intensive infrastructure and capital are likely to become obsolete/unsustainable, with associated risks of stranded assets. Any attempt at a high-carbon path will, before long, destroy itself through the hostile environment it creates.
- There is a deep inequity in that rich countries grew wealthy on high-carbon growth and poor countries will be hit particularly hard by climate change. Recognition of that inequity must play a strong part in building international collaboration but must not be allowed to block progress; that would be the most inequitable of all outcomes.
- The emissions arithmetic for a 2°C path is stark: stronger action will be required from developing countries, *even if developed countries reduce their emissions to zero by 2030*. The deep inequity and the arithmetic imply rich countries have a great responsibility to act radically themselves and to support developing countries' transitions to low-carbon growth and development paths. Overcoming poverty and fostering sustainable growth and development support each other: if we fail on one, we fail on the other.
- *Equitable access to sustainable development* is an attractive way of framing the issues that may help bridge the gap between developed and developing countries. Focus should be strong across each of *equity*, *access* and *development*, with countries coming together in a *dynamic partnership* where the *choice* of the sustainable development path is determined by the people of developing countries and that path is supported by rich countries (providing *strong example* and *access* to know-how, technology and finance).

Recklessly slow or a rapid transition to a low-carbon economy? Time to decide[1]

Mattia Romani,[2] James Rydge,[3] Nicholas Stern[4]

1. Introduction and summary

International negotiations on climate change have been slow and challenging, partly due to the rigid nature of the United Nations Framework Convention on Climate Change (UNFCCC) processes and the slow convergence, sometimes intransigence, in the positions of participants. Nonetheless, there has been important progress over recent years, although ambition has been too low and outcomes inconsistent with the stated objective of a 2°C path.[5] The 18th session of the Conference of Parties (COP18) to the UNFCCC in Doha, Qatar, in late 2012, is an opportunity for advance towards the goal of a global agreement in 2015, which will come into force in 2020. COP18 is expected to make progress but major breakthroughs seem unlikely.

More rapid progress on managing climate change requires much greater awareness and recognition that we are heading in a difficult and dangerous direction. Whilst there are already signs of progress, change and discovery across the world, the overall pace is recklessly slow. The emissions landscape has changed with developing countries now emitting more than half of the total. The emissions arithmetic is stark and implies developing countries must take much stronger action than currently planned, *even if developed countries reduce their emissions to zero*. There is a deep inequity here in the current and past emissions of rich countries and the particular vulnerability of poor countries to climate change; the current and historical injustices are profound. But they do imply that rich countries have a great responsibility not only to cut their own emissions radically but also to support developing countries' transitions to low-carbon growth and development paths.

Of great importance to accelerating action is greater awareness and understanding of the attractiveness of the emerging low-carbon, resource-efficient development/growth paths. Developing countries are already considering economic growth, environmental responsibility and climate resilience together so that their development aspirations can be achieved in a sustainable way. A transition towards these paths would likely involve a dynamic period of innovation, learning, investment, empowerment and growth; just as the world has seen in past periods of rapid technological change from the industrial revolution starting in the 18th century to ICT in recent years. These paths cannot and should not come

[1] The authors are very grateful for the advice and comments of Bob Ward and for the research assistance of Ioanna Sikiaridi.
[2] Director, Green Growth Planning and Implementation, Global Green Growth Institute and Senior Visiting Research Fellow, Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science.
[3] Dahrendorf Research Fellow, Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science.
[4] I.G. Patel Professor of Economics and Government at the London School of Economics and Political Science, and Chairman of the Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science.
[5] For a review of recent progress see: Stern and Rydge, 2012, *The New Energy-industrial Revolution and International Agreement on Climate Change*, Economics of Energy and Environmental Policy, Vol. 1, No. 1, 1-19.

from stopping growth but from breaking the link between economic activity and emissions. Economic activity requires energy but energy does not require emissions.

Interpreting these issues in terms of access to opportunities, or "equitable access to sustainable development", has great potential for promoting collaboration and bridging divides between developed and developing countries. It could enable us to find a way forward where all countries come together and take stronger action. Equitable access to sustainable development recognises the responsibility of rich countries to support developing countries' choice of sustainable development paths through a dynamic partnership where developed countries contribute to the options and scope for choice of path, in part through their own example, and provide support for access to, and implementation of, the paths chosen by developing countries. This perspective is far more productive than the rigidity of redlines and pre-conditions as an excuse for delay amongst both developed and developing countries. This is not a zero-sum and timeless game.

Over the past decade the world has invested substantial resources in better understanding the challenges of climate change and there have been great advances of knowledge. The scale of the risks of climate change are far better understood today, particularly in relation to impacts on poorer countries. We also understand much better the technologies needed to reduce the risks, both in terms of reducing emissions and managing the consequences of inevitable climate change. Finally, we have grappled with the economics of the challenge and have come a long way, including making real advances in our understanding of the policies needed to create and scale up new technologies and accelerate change, and in our understanding of the potential benefits of the transition to a low-emission, more resource-efficient economy. Of course there is more learning to do; we will continue to advance our understanding of the challenges and of the potential responses. But our understanding is now good enough that we know how to begin, what we need to do to start along the path, and how, in large measure, to do it. We can now move strongly along a path which can radically reduce the immense risks. We must recognise very clearly that delay is the most dangerous and inequitable of outcomes.[6]

2. Where we are heading: prospects for global emissions

Emission reduction policies, actions and events over the last decade have made a difference. For example: emissions in the EU-15[7] in 2011 were 14 per cent below 1990 levels, compared to their Kyoto target of an 8 per cent reduction 2008-2012;[8] and China achieved a reduction in energy intensity of 19 per cent over the period of the 11th five-year plan.[9] However, notwithstanding economic crises and temporary small falls in emissions in a few countries, overall emissions continue to rise.

Global emissions are now over 50 billion tonnes of carbon-dioxide-equivalent (CO_2e)[10] p.a. and are likely to keep rising for the next few decades. There are many different ways to

[6] Some of these arguments are developed in Stern, 2012, *Ethics, Equity and the Economics of Climate Change*. See: http://www2.lse.ac.uk/GranthamInstitute/publications/WorkingPapers/home.aspx

[7] EU-15 countries include: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom.

[8] Source: http://ec.europa.eu/clima/policies/g-gas/index_en.htm (Estimates exclude LULUCF).

[9] Source: http://www.gov.cn/english/official/2012-10/24/content_2250497_4.htm

[10] For an explanation of CO_2e see: Gohar and Shine, 2007, *Equivalent CO_2 and its use in understanding the climate effects of increased greenhouse gas concentrations*, Weather, Vol. 62 (11), pages 307–311.

look at where we might be heading, e.g. the United Nations Environment Programme (UNEP) 2012 "Bridging the Emissions Gap" report, the International Energy Agency 2012 World Energy Outlook scenarios, analysis based on China's emissions not peaking until around 2030 or later,[11] and estimates of the world's continued reliance on hydrocarbons. It appears that on current policies and plans hydrocarbons are likely to remain at around 75 to 80 per cent of total energy supply into the 2030s.[12]

These different perspectives, based on current plans and intentions, arrive at similar conclusions. At best, it appears likely that global emissions will plateau at around 50 billion tonnes of CO_2e for the next two decades, with the strong possibility they may go much higher by the mid-2030s, perhaps to 55-60 billion tonnes p.a. If there is no further action to reduce emissions, beyond current policies already in place, we could see emissions of around 65 billion tonnes by the mid-2030s (IEA, WEO, 2012, p. 246). These levels of emissions are completely inconsistent with a 2°C path.[13]

Emissions in the region of 50 (65) billion tonnes CO_2e by the mid-2030s would likely imply concentrations of GHGs in the atmosphere of over 650 ppm (950 ppm) at stabilisation a century or so from now, consistent with temperature increases of around, 50-50 chance, 3.6°C (5.3°C) (see IEA WEO, 2012, p. 246-247). The planet has probably not experienced 3°C for over 3 million years (5°C for over 30 million years). This is far outside the range of experience of modern civilisations, with their sedentary agriculture and village settlements, which have been present for the past 8-9,000 years. At these temperatures there are strong possibilities of disruptions to climate and local habitats that would require hundreds of millions of people to move, with risks of severe and extended conflicts.[14] Much of the great advances in development, including in health and education, of the last few decades would likely be reversed. The risks are immense.

3. The pace of change.

Our understanding of the scale of the risks, the technologies required and the economics of the alternative low-carbon, resource-efficient paths has advanced greatly in recent years. The need for and attractiveness of rapid action should be clear. But action is recklessly slow. We are currently behaving as if change on the scale and pace required is too difficult and costly and delay is not a problem. Now is the time to rise above the vested interests, the rigidity of the processes of negotiating global agreement, intransigent behaviour and the fear of change. While the politics may be difficult the situation is not hopeless. Now is the time for leadership.

---

[11] This assumption is supported by a number of studies, including: the Chinese Academy of Engineering, 2011, *Study on China's Medium and Long Term Energy Strategy*, China Science Press, Beijing; and Jiankun, H., 2012, *China's Strategy for Energy Development and Climate Change Mitigation*, Energy Policy 51, 7-13.

[12] See, for example, Daniel Yergin's 2012 book *The Quest: Energy security and the remaking of the modern world*, Penguin Books.

[13] A 2°C path would require global emissions to fall from current levels to around 44 billion tonnes of CO_2e in 2020, to well below 35 billion tonnes in 2030, and well below 20 billion tonnes of CO_2e in 2050 (see Stern, 2012, Lionel Robbins Lectures, Lecture 1). Most nations now agree, as expressed in global negotiations (the agreement at Cancun at the UNFCCC meeting of December 2010), that limiting the rise in global temperature to 2°C is necessary in the sense that levels above this are (sensibly) regarded as dangerous. A 2°C path is still achievable but the window is fast closing (See IEA WEO, 2012).

[14] See Box 1-2 and the section on disruptive migration in: Steinbruner, Stern, Husbands (eds), 2012, Climate *and Social Stress: Implications for Security Analysis*, National Research Council of the National Academies.

History offers many relevant examples of rapid change. For example, France constructed and started operating around 45 nuclear reactors over a relatively short 15 year period, starting in the mid-1970s.[15] Today France's reactors generate nearly 80 per cent of the country's electricity. And in the early 1990s the privatisation of the UK electricity sector led to a "dash-for-gas" which saw gas replace coal and oil in electricity generation - energy CO_2 emissions fell over 6 per cent between 1990 and 1995 and electricity prices fell.[16]

Whilst change needs to be much broader and faster, we can see important examples now.

- *Coal to gas*: The shale gas boom in the US has accelerated a transition from coal to gas in electricity generation. The share of gas in electricity generated increased from 19 to 25 per cent 2005 to 2011 and the share of coal decreased from around 50 to 40 per cent.[17] The rapid transition was possible due to changes in the relative prices of fossil-fuels (falling domestic gas prices due to the shale gas boom, which was possible due to technological advances in "fracking"), stronger EPA regulations on emissions from coal, and spare gas generation capacity on the network.[18] The impact on US energy emissions has been large. US energy emissions decreased by 8.6 per cent over the period 2005-2011, with "fuel switching" from coal to gas in the power sector accounting for up to 50 per cent of this reduction.[19,20] Factors such as the recession, relatively mild winters in 2010 and 2011, and an increase in renewable energy generation account for the other half of the decrease. Growth in US renewable energy investment and renewable electricity generation has remained strong over this period, driven by renewable portfolio standards in 29 states and renewable energy tax credits. This example demonstrates that changes in relative prices (driven by technology in this case) accompanied by strong regulation and policy, can lead to rapid transformation of a sector characterised by long-lived and "locked-in" capital.
- *Solar PV*: Module prices have declined from over US$ 100/W (Watt) in the 1970s, to around US$ 2/W in 2010, to around US$ 0.90/W today. These price falls are opening up new opportunities for the industry. For example, Grameen Shakti is currently selling solar units strongly in Bangladesh at US$ 1/W. The Chairman Muhammad Yunus says he could "cover the country" at US$ 0.50/W.[21] We have often underestimated the learning rates of new technologies, with a study from 2005 estimating US$ 1/W would not be achieved until 2023 (see Candelise, Winskel and Gross, 2012).[22] The pace of change in the solar industry has been so rapid that it has, perhaps inevitably, resulted in instability. Overcapacity or "bubbles" are not uncommon in sectors undergoing rapid

[15] Source: http://www.world-nuclear.org/info/inf40.html
[16] Source: Bowen and Rydge, 2011, *Climate Change Policy in the United Kingdom*, OECD Economics Department Working Paper, No. 886.
[17] Source: http://www.eia.gov/
[18] The effect on global emissions is less clear as the US is now exporting displaced coal to Europe, where this is displacing higher priced and cleaner gas (IEA WEO, 2012). It is also less clear if a rise in US gas prices, as forecast, would lead to a switch back to coal in the US. This will depend, in part, on the impact of EPA regulations on coal.
[19] Broderick and Anderson, 2012, *Has US Shale Gas Reduced CO_2 Emissions? Examining recent changes in emissions from the US power sector and traded fossil fuels*, Tyndal Manchester Climate Change Research.
[20] US emissions from energy were nearly 6 billion tonnes CO_2 in 2005 and had declined by nearly 520 million tonnes by 2011.
[21] Personal discussion.
[22] Candelise, Winskel and Gross, 2012, *The dynamics of solar PV costs and prices as a challenge for technology forecasting*, Submitted to the Renewable and Sustainable Energy Review Journal.

growth and/or transformative change; for example, in the railways in the 19th century[23] and the 'dot com' boom in 1990s,[24] both industries with immense economic and social benefits. And where competition, innovation and discovery are of the essence some entrepreneurs will "back the wrong horse" and pursue technologies which prove to be unsound or uncompetitive. That is the nature of entrepreneurship, rapid technological change and industrial revolutions.

- *Combined Heat and Power (CHP)*: CHP plants located near industry have great potential to accelerate industrial energy efficiency. CHP has expanded rapidly in the US over recent years from around 12 GW (billion Watts) of installed capacity in 1980 to around 82 GW today (around 8 per cent of total US generation capacity) and the technical potential for an additional 130 GW. There is also some scope for learning with costs of CHP expected to fall.[25] To accelerate the pace of change the Obama Administration signed an Executive Order in August 2012 that established a target of an additional 40 GW of CHP deployment by 2020.[26] At this pace, CHP will transform US industry in terms of energy efficiency, increasing the level of productivity and competitiveness of key industries. The consequences for growth and jobs could be significant. Estimates indicate that a target for CHP of 20 per cent of US electricity generation capacity for 2030 (equivalent to adding 156 GW of new capacity) has the potential to generate US$ 234 billion in new investment and create nearly 1 million new highly-skilled jobs throughout the US.[27]
- *US Navy*: Security concerns can accelerate the pace of change. For example, the US Navy, faced with the high cost and risk of fossil-fuel use has driven forward the development of third generation biofuels (from waste and algae). Costs have fallen sharply with US Navy algal biofuel purchases costing around US$ 424 per gallon in 2009 and falling to around US$ 27 per gallon in 2011.[28] The US Navy target is for 50 per cent of total on- and off-shore energy consumption to come from (non-hydrocarbon) alternative sources by 2020.[29]

Progress in other crucial areas is slow.

- *CCS*: The Global CCS Institute indicates that the pace of change in CCS is moving far too slowly. Around 130 CCS projects must be operational by 2020 for a 2°C path. Today there are 8 operational CCS projects, 8 under construction and 59 in the planning pipeline, not all of which will proceed: there is a large gap between what is required and what is planned. However, there are some encouraging signs. Nineteen developing countries, including China, are involved in various stages of CCS development, mostly at the early stages. And some developed country governments, including the UK, are pushing forward with public funding to support CCS

[23] See: Odlyzko, A., 2010, *Collective hallucinations and inefficient markets: The British Railway Mania of the 1840s*, University of Minnesota.
[24] See: Perez, C., 2009, *The double bubble at the turn of the century: technological roots and structural implications*, Cambridge Journal of Economics 33, 779–805.
[25] Source: IEA, 2010, ETSAP Technology Brief: CHP, May 2010.
[26] Source: US Clean Heat and Power Association, CHP Industry Hails White House Executive Order Supporting Combined Heat & Power, Press Release, August 30.
[27] Source: Oak Ridge National Laboratory, 2008, *Combined Heat & Power: Effective Energy Solutions for a Sustainable Future*, ORNL.
[28] Source: http://www.reuters.com/article/2012/07/02/us-usa-navy-greenfleet-idUSBRE86106X20120702
[29] Source: http://www.navy.mil/submit/display.asp?story_id=50710

commercialisation. There are a range of research programmes and demonstration projects designed to accelerate innovation and drive down costs through learning-by-doing. Examples include two commercial-scale power sector demonstration projects that will open in 2014, one in the US (Kemper County) and the other in Canada (Boundary Dam). Norway has also recently (August 2012) opened a US$ 1 billion industrial scale CCS test centre, "CO_2 Technology Centre Mongstad", for post-combustion carbon capture.

- *Transport*: Accelerating the pace of change in decarbonising transport, particularly the electrification of vehicles, is crucial. Whilst progress in electric and hybrid-electric vehicles is promising, deployment is slow. Around 40,000 electric and plug-in hybrid electric vehicles were sold globally in 2011.[30] The IEA BLUEMap scenario (consistent with a 2°C path) indicates sales of around 7 million units p.a. are needed by 2020 (IEA, 2011).[31] A significant acceleration in deployment is required but battery costs and limited charging infrastructure are preventing more rapid uptake. Cost reductions are expected over time. Estimates from the US suggest the price of a complete lithium-ion battery pack could fall from between US$ 500-600/kWh today to around US$ 160 by 2025; batteries under US$ 250 (and fuel prices at or above US$ 3.50 a gallon) could see electric vehicles competitive with advanced internal-combustion engines.[32] Research and development of a new generation of high-capacity batteries using advanced materials is also progressing but these innovations are some way from market. We have seen with solar and other areas that with strong commitment and good policies, progress can be much more rapid and costs fall much faster than might be anticipated.
- *A brutal reality and the ignoring of a fundamental market contradiction in fossil-fuel reserves*: Only around 30 per cent of global proved fossil fuel reserves can be burnt "uncaptured" between 2012 and 2050 for a 2°C path (IEA WEO, 2012). Therefore either the development and deployment of CCS on scale must be very rapid or 70 per cent of these resources must stay in the ground or the 2°C target will be greatly exceeded. The world is not facing up to this basic logic. It is not possible to consistently believe two things (i) the declared 2°C target can be achieved (ii) the current fossil-fuel reserves have the value attributed to them, unless there is an expansion of CCS at a pace which currently seems implausible.

4. The low-carbon, resource efficient path is attractive and feasible: the only sustainable route to growth, development and overcoming poverty.

The transition to a low-carbon, more resource-efficient economy will likely involve a dynamic period of technological change, innovation, learning, empowerment, entrepreneurship, investment and growth. It will also promote greater energy independence and reduce exposure to fluctuations in the prices of fossil fuels and other natural resources. Continuing rise and volatility in natural resource prices seems likely given increasing constraints on their supply relative to expanding demand.

[30] Source: http://www.cleanenergyministerial.org/OurWork/Initiatives/ElectricVehicles.aspx
[31] Source: http://www.iea.org/roadmaps/plug_in_electric_vehicles.asp
[32] Source: McKinsey Quarterly, July 2012.
http://www.mckinseyquarterly.com/Battery_technology_charges_ahead_2997

Accelerating the pace of change and the transition to low-carbon, resource-efficient growth is, in large measure, about strong government policy to deal with market failures. Each of these market failures requires careful attention: different failures point to different instruments. And the policy instruments should be designed to be coherent and mutually supportive. Taxing the "bad", – in this case carbon – will ensure that investment going forward is not distorted by its ignoring damage to others and does not lead to "lock-in" of high-carbon, resource-intensive infrastructure. But there are other crucial market failures: policy will fail to generate the scale and urgency of the response required if it considers only the greenhouse gas externality. Policy for the wide range of relevant market failures in this context should include:

- *Greenhouse gases*: a combination of carbon taxes / cap-and-trade / regulation;
- *R,D&D* (research, development and deployment): tax breaks for private R,D&D, feed-in tariffs (FIT) for deployment, direct public investment and public-private partnerships in research and development institutions;
- *Imperfection in risk/capital markets*: risk sharing/reduction through guarantees, equity, feed-in tariffs, floors on carbon prices, green investment banks. FIT straddles the first 3 imperfections;
- *Networks*: electricity grids, public transport, broadband, recycling, community-based insulation schemes. Government frameworks needed for networks to function effectively;
- *Information*: labelling and information requirements on cars, domestic appliance, products more generally. Awareness of options relevant for both consumers and producers;
- *Co-benefits*: valuing ecosystems and biodiversity, valuing energy security, regulation of dirty and more dangerous technologies.
- *Reducing the overconsumption of resources*, such as energy, water, land, will require allowing these markets to work more efficiently, and prices to reflect the real cost of overconsumption.

We should not see these policies in terms only of static re-allocations or corrections. Policy concerns the dynamics of change and learning. This is about fostering and accelerating a transition to a more attractive low-carbon growth path. Interventions of this kind are pro-market: it is about making existing markets work better, allocating investments more efficiently and creating new markets. Failure to act to overcome crucial market failures is anti-market. Thus it is odd to find some of those who understandably champion the virtues of entrepreneurship and competition opposing action on environment and resource management and failing to understand this basic logic of markets.

Many developed economies are already taking action to take on and meet commitments to reducing emissions, such as the UK, EU, Australia, and many more. And many states and cities, particularly in the US, are acting strongly: 38 US states have climate action plans; 23 US states have greenhouse gas emissions targets; there are 5 multi-US-state greenhouse gas initiatives;[33] and US cities including NYC, Chicago, Los Angeles and Portland have climate change plans and emissions targets. Some firms are also acting as they see the short- and

[33] Source: http://www.c2es.org/us-states-regions/policy-maps

long-term benefits from a low-carbon path, e.g. DuPont, M&S, and Walmart.[34] Public/private collaborations are also emerging, e.g. Maersk and US Navy.

But it is the leadership and example of developing countries that is proving particularly powerful in terms of laying out an alternative pathway for growth and development. For example, Brazil, China, Colombia, Ethiopia, India, Indonesia, Philippines, South Africa, and many more are developing strong plans for emissions reductions in the context of sustainable growth. Important examples are China's 12th 5-year plan, including its energy efficiency and emissions intensity targets, and pilot carbon trading schemes; India's National Action Plan on Climate Change (NAPCC), which includes eight "National Missions" to promote development, mitigation and adaptation objectives; and Ethiopia's Climate Resilient Green Economy (CRGE) strategy, which aims to develop a resilient, low-carbon and resource efficient middle-income economy by 2025.

The power of the example, whether from developed or developing countries, or from farms, cities or firms, is crucial. The spur to creativity can be immense. We are already seeing through these examples that alternative paths can be full of discovery and co-benefits which can come through quickly. These are paths where overcoming poverty, growth and environment responsibility can all come together. The necessary investment will be substantial, but should be manageable and can have high returns beyond the reduction in climate risks.[35]

We must keep reminding ourselves, however, that notwithstanding these positive examples the overall pace of change is far too slow.

5. Equitable access to sustainable development (EASD)

Equitable access to sustainable development is a crucial and creative idea that emerged mainly from developing countries[36] in Cancun at the UNFCCC COP 16 in November/December 2010. It could be, if developed wisely, a way of moving beyond rigidity and impasse. It can be interpreted as involving a number of key elements. At an overall level one can see four.

- Global action to ensure the radical reduction of risks of climate change impacts so that development is possible;
- The ability to adapt to and manage the risks of inevitable climate change;
- The ability to discover, pursue and implement new ways of doing things, and the ability to be able to reduce emissions while growing and reducing poverty.
- These will involve *access* to:
    - *know-how;*
    - *technology;*
    - *finance.*

[34] See http://www.cleantech.com/global-cleantech-100/ for a list of the top 100 firms in clean technology innovation.
[35] A range of studies have estimated total investments to be in the range of 1-2-3 per cent of global GDP. For an overview see The World Bank, 2010, *World Development Report 2010: Development and climate change*.
[36] We believe it to have been from the Indian delegation at Cancun led by Jairam Ramesh, then the Environment Minister.

Other key elements are *empowerment, example and choice*.

- Scope for *choice* in the path the people of a country choose for their development (be it at the individual, rural, town, city, region or state level) and support for implementation from developed countries. This will involve a partnership; doing things together.
- Strong action from rich countries on their own emissions, both to reduce climate risk and to create new examples and options for development. This will be central and crucial.
- Much of the power of the example and partnership will involve transfers of know-how, in the sense of new ways of doing things at local and community levels and how to make things work well, including socially and politically, as well as narrower forms of technological advance.
- In order for the choice of path to be genuinely open and equitable, it will need to be financed with support from rich countries through the development of a range of both public and private sources. If these are to work well, their design must consider basic public finance criteria including revenue, incidence/equity, efficiency, feasibility, and acceptability.

These are examples of general principles which could allow the development of the concept of "equitable access to sustainable development". There is much analytical work to do and discussion to be had but our focus in international collaboration should be on these issues. The focus should be strong across equity, access and development; they should come together to create and define a dynamic partnership between countries where the choice of path is determined by the people of developing countries and that path is supported by rich countries. Collaboration between developed and developing countries in know-how, policies, technologies, the learning processes and resources will be of the essence.

It is crucial that developing countries are central to action. The emissions landscape has changed rapidly over recent years with the share of global carbon dioxide (CO_2) emissions from developing countries (defined here as Non-Annex I) increasing from 33 per cent in 1990 to 40 per cent in 1997, when the Kyoto Protocol was signed, to around 55 per cent today (See Table A, Appendix).

Estimates of future CO_2e emissions indicate that this rising trend will continue. Total emissions from developing countries could be as high as 37-38 billion tonnes of CO_2e in 2030 (around 70 per cent of global CO_2e emissions), and total global emissions for a 2°C path can only be around 32-33 billion tonnes in that year (see Figure A, Appendix). This arithmetic implies that it is simply impossible to manage climate change unless developing countries take stronger action than currently planned, *even if developed countries reduce their emissions to zero by 2030*. In quantitative terms it is inevitable that they are at centre stage. And it is in developing countries self-interest that they take stronger action now given the attractiveness of the alternative paths and the dangers of delay.

Given the inequity and the stark reality of the arithmetic, EASD is an attractive way forward that maintains equity issues as central and embeds them in the idea of rich country support for fostering the dynamic and attractive transition to the low-carbon economy in both their own countries and as a driver of growth and poverty reduction in the developing world. It reframes interpersonal and cross-country questions and is a promising way of

casting the policy issues and analysis. It contrasts greatly with the defensive and narrow perspectives of self-interest, zero sum games and redlines all too common in the past and in current negotiating positions. The reality of the science implies that such postures are the opposite of self and common interest.

EASD has great potential to empower the people of developing countries who will make sustainable development a reality; it will enable people to participate more effectively in the economy and society.[37] Empowerment could involve a new generation of low-carbon entrepreneurs driving forward mitigation, adaptation, low-carbon development/growth and poverty reduction in developing countries. For example, at a local level, rapid cost reductions and technological advances in solar power present a real opportunity to bring electricity to the 250 million or so people in India who are currently without power (there are around 1.3 billion people in the world without access to electricity and 2.7 billion without access to clean cooking facilities).[38] Solar power provides low-emissions electricity that is more resilient than often unreliable or corruptly managed grid-based electricity supply and empowers local communities in ways that promote development and overcome poverty. It can enable both children and adults to study at night and have access to the internet. It can enable women, who can spend less time in the often dangerous activity of collecting and transporting biomass over long distances, to perhaps establish local businesses, e.g. solar charging stations. The transition to low-carbon, more resource-efficient growth can also be one of increasing inclusiveness, for example by facilitating the deployment of infrastructure to enable better access to basic needs such as water and energy. It can deliver opportunities for growth creation in rural and forested areas, by monetising opportunities to reduce emissions from deforestation or to preserve biodiversity.[39]

Entrepreneurs from the private sector are already emerging and promoting the social and development potential of solar power. With off-grid decentralised energy supply options now technically feasible the challenge is to find the finance to enable the investment. The UN *Sustainable Energy for All* initiative estimates nearly US$ 1 trillion in cumulative investment is required by 2030 to achieve universal energy access (IEA WEO, 2012). With the right kind of finance (often micro-finance) poor people are very willing to make the investments themselves, suggesting the private returns are valued highly enough to justify the investment. The social returns are still higher. Entrepreneurial organisations such as SELCO in India work with financial institutions to find innovative ways for poor people to obtain loans to invest in access to solar energy, and these loans have already reached over 100,000 households.[40] GramPower has established an innovated business model supplying small, energy efficient, smart, micro-grids to local communities. Local residents access the grid through a pay-as-you-go prepayment model. They are also extending their model to Telecom towers and businesses that are currently dependent on high-cost diesel generators.[41] These new solar entrepreneurs and their businesses will accelerate the pace of low-carbon development, increase resiliency, and avoid the lock-in of traditional and often unreliable, dirty and costly high-carbon infrastructure.

[37] See, Stern, Dethier and Rogers, 2005, *Growth and Empowerment: Making Development Happen*, MIT Press.
[38] Source: World Energy Outlook 2011, *Energy for All: Financing Access for the Poor*, IEA/OECD.
[39] The World Bank, 2012, *Inclusive Green Growth: The pathway to sustainable development.*
[40] Source: http://www.selco-india.com/finance.html
[41] Source: http://www.grampower.com/

The Indian government, also recognising the potential of solar power for low-carbon development and empowerment, is implementing one of the largest decentralised, off-grid renewable energy programmes in the world. The Jawaharlal Nehru National Solar Mission aims to build 2 GW of solar power capacity by 2022, connecting millions of people who are not linked to the national power grid, and deploying 20 million solar lighting systems for rural areas.[42]

6. Conclusion

The world is heading in a difficult and dangerous direction and action is recklessly slow. We know what we need to do, how to do it and there are some signs of action: we are seeing the beginnings of a transition to feasible and attractive low-carbon and more resource-efficient paths which can radically reduce the immense risks of climate change. Greater pace of action is possible and strong policy will be key. The politics is not hopeless. Notwithstanding the economic and financial crises in the developed world and campaigns of disinformation from climate deniers, there are influential voices offering and seeking such leadership, as was evident with the comments of New York City Mayor Bloomberg after Post-tropical Storm Sandy.[43] Strong leadership will be crucial given the stark reality of the emissions arithmetic for a 2°C path and its requirement for radical change in both developed and developing countries. What we need now is renewed leadership that can forge a new way forward that brings developed and developing countries together in a way that builds trust and overcomes barriers to progress.

Equitable access to sustainable development is a concept that, with strong leadership, has great potential to bridge the divide and build dynamic partnerships between countries, creating the opportunity and scope to accelerate action across the world. Its development requires analysis and discussion. Equity is clearly central; this concept must involve recognising that rich countries have a great responsibility to support the transition of developing countries to the new low-carbon growth paths. These paths are likely to be full of creativity, innovation and growth and will involve breaking the link between growth and emissions, not stopping growth. With the potential of alternative low-carbon paths so real, accessible and attractive, it is surely reckless to go on as we are with emissions rising year-on-year and our negotiations dogged by narrow-mindedness and rigidity.

[42] See http://www.mnre.gov.in/solar-mission/jnnsm/mission-document-3/
[43] See http://www.bloomberg.com/news/2012-11-01/a-vote-for-a-president-to-lead-on-climate-change.html

Appendix.

Table A illustrates the changing share of emissions between developed (Annex I, including the US) and developing (Non-Annex I) countries. In 1997, the time of signing of the Kyoto protocol, developing country emissions were around 40 per cent of global CO_2 emissions. Today that figure is closer to 55 per cent.

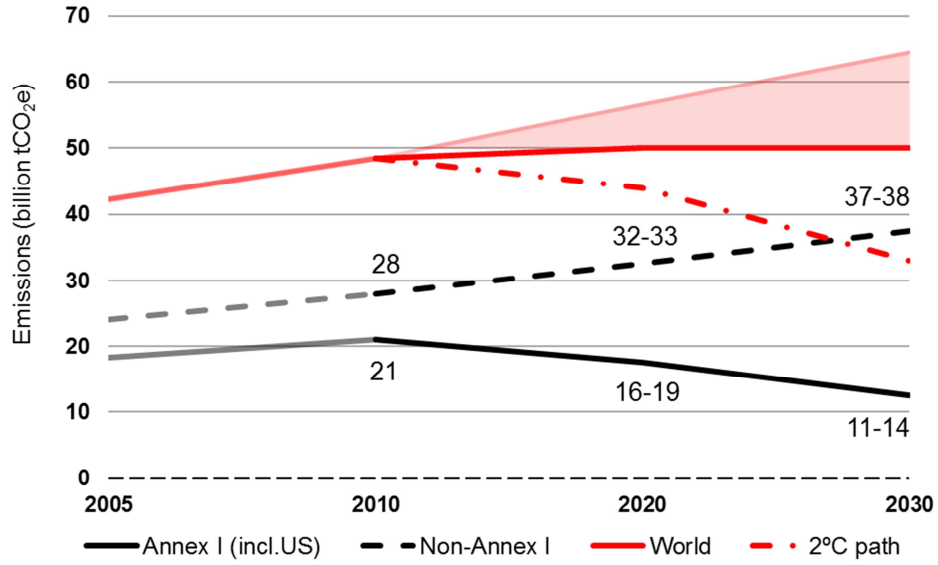
Table A: Changing shares of global emissions (CO_2).

Group	1990	1997	2008
Annex I (incl. US)	67%	60%	47%
Non-Annex I	33%	40%	53%
Annex I (incl. US): world GDP share (PPP)	71%	65%	58%
Non-Annex I: world GDP share (PPP)	29%	35%	42%

Source: CAIT (WRI); World Bank, 2012. (PPP, current International US$).

The breakdown of emissions for Annex I:Non-Annex I might be around 35:65 in 2020, see below.

Figure A: Prospects for global emissions (CO_2e) in 2020 and 2030 based on current ambitions, targets and plans.



Source: Stern, 2012, Lionel Robbins Lectures, Lecture 1. http://cep.lse.ac.uk/_new/events/event.asp?id=140

Figure A illustrates that developing country emissions could be as high as 37-38 billion tonnes CO_2e in 2030 (around 70 per cent of global CO_2e emissions with perhaps around 55 per cent of world GDP in 2030) and emissions for a 2°C path (50-50 chance) need to be well below 35 billion tonnes CO_2e, probably around 32-33. Strong action on emissions will be required from developing countries, e*ven if rich countries reduce their emissions to zero by 2030* (it is more likely they will reduce emissions to around 11-14 billion tonnes).

The story is similar on a per capita basis. Per capita emissions in developing countries can only be around 4.5 to 5 tonnes CO_2e in 2030, at a maximum, for a (50-50 chance) 2°C path, assuming developed country emissions are zero in 2030 and population in the developing world rises to around 7 billion (source: UN World Population Prospects, 2010 Revision). China is already around 7-8 tonnes per capita and will likely rise to over 10 by 2030. India is around 2 per capita today will likely double by 2030. And Latin American countries are already at 5-6 tonnes per capita.