Chapter 19

What is the top priority on climate change?

Paul Klemperer

Paul Klemperer, born in 1956, studied engineering at Cambridge University, and was awarded an MBA and a PhD in economics at Stanford University in Palo Alto, California. He is currently Edgeworth Professor of Economics at Oxford University. His main research interests are in industrial economics theory and policy, competition policy, and microeconomic theory, especially auction theory. He has been a Member of the UK Competition Commission, and has advised the US Federal Trade Commission, the European Commission, and many other government agencies and private companies.

Action on climate change is urgently needed. Substantial uncertainty about the importance of the problem remains,[1] but this uncertainty means we should worry more, not less, because while things may not be as bad as the most likely scenarios suggest, outcomes could also be a lot worse.[2] What, therefore, should be the West's top priority for climate change policy?

The critical issue

The critical issue is that no strategy will work unless it is consistent with developing countries' continued economic growth.[3] So we are unlikely to be able to reduce the use of 'dirty' energy sufficiently unless we can find a cheap, clean, substitute.[4] And that requires innovation.

Developing countries are not going to give up the immediate aspirations of their (often growing) populations in exchange for environmental benefits that arise largely in the future. These nations simply do not have the luxury of worrying about preserving the environment for their great-grandchildren. China, for example, stresses even in the Foreword to its National Climate Change Programme that 'economic and social development and poverty eradication are [its] first and overriding priorities'.[5] Whether or not this is morally right (though it may be justified for a developing country) is irrelevant. It is a political imperative for the leadership of a country in which, according to the latest figures, about 200 million people live below the World Bank's 'dollar-a-day' poverty line, and in which 100 million are illiterate.[6]

[1] See Klemperer (2007), and also, e.g., Table 1 of Nicholas Stern's paper in this volume.
[2] See Klemperer (2008 a), and also Topic 6.2 in the IPCC's 4th Synthesis Report, 2007.
[3] This point applies across the polluting sectors, including, for example, deforestation (see, for example, Angelsen and Kaimowitz (1999), Lambin *et al.* (2001)), but I am focusing here on energy, where policy may be most essential. See also Sunita Narain's essay in this volume for a discussion of developing countries' climate change priorities.
[4] I am *not* arguing that systems for pricing carbon, such as carbon taxes or a 'cap and trade' permit system, are not helpful. But they are not sufficient.
[5] However, the Chinese government is merely quoting the statement of the United Nations Framework Convention on Climate Change (UNFCCC, 1992) that 'economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties' (article 4, paragraph 7).
[6] This is not, of course, to suggest the Chinese are less 'moral' than the West – on the contrary, their value system may place more weight on, and their culture offers more support to, intergenerational justice. And, of course, many people from all parts of the world are concerned about the effects of climate change on current as well as future generations, and regard environmental protection as a necessity, not a luxury. (In China, Pan Yue, deputy director of China's state Environmental Protection Administration, who was named the New Statesman's 'Person of the Year 2007', is just one notable example.)
I focus especially on China among the rapidly-developing countries, because of its size, and because of my focus on energy use; other countries are obviously especially important in the context of deforestation. Keidel (2007) estimated that 300 million Chinese lived below the 'dollar-a-day' poverty line (which is calculated on the basis of 'purchasing power parity' exchange rates that compare prices across different countries), but Chen and Ravallion's (2008) more recent work suggests an estimate of 200 million for 2005, and that this number is rapidly declining. The World Bank (2008) gives an illiteracy figure of 100 million for 2000; the UN (2007) give an estimate of 130 million for 2003.

Thus, although China has probably now overtaken the US to become the world's number one polluting nation,[7] its officials emphasize that it has no obligation to cut emissions under the Kyoto Protocol. Moreover, it seems unlikely to do so voluntarily, at least on the scale required – consider, for example, China's recently-announced plan to build 97 new airports in the next 12 years (while the UK has agonized about whether to build a single extra runway at Heathrow!).

The challenge

Much recent research suggests that we need to stabilize greenhouse-gas concentrations below 400 parts per million (ppm) carbon dioxide equivalent if we wish 'to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted'.[8] Indeed, the IPCC says that stabilization at around 380 ppm carbon dioxide equivalent would yield a more than 20% probability that global warming will exceed 2 °C, the level that is commonly referred to as the threshold for 'dangerous' warming (and the EU has adopted the target of keeping the temperature increase below this level).[9]

Perhaps these estimates are pessimistic. But even stabilizing greenhouse gas concentrations at 500 ppm carbon dioxide equivalent (whereby temperature increases above 2 °C would be very likely[10]) requires a roughly 50% reduction in greenhouse-gas emissions by 2050. Allowing for population growth, this requires a two-thirds fall in per-capita emissions to about 2–2.5 tonnes carbon dioxide equivalent by that date.[11]

[7] See Auffhammer and Carson (2007). Note also that China's energy intensity is 1.5 times the global average (World Bank (2008) figure for 2005).

[8] Hansen *et al.* (2008) write that achieving this objective requires stabilization at 350 ppm CO_2; including all greenhouse gases, this would correspond to a little under 400 ppm CO_2 equivalent if today's relative atmospheric concentrations of the different greenhouse gases were maintained. In 2005 levels were 380 ppm CO_2 and 430 ppm CO_2 equivalent (Stern 2007, Section 1.2). The campaign to set a target of 350 ppm CO_2 endorsed by, among others, Al Gore at the United Nations Climate Change Conference in Poznań, 2008 (see http://www.un.org/climatechange/blog/2008/121208.shtml) is based upon Hansen *et al.* (2008), and refers to levels of CO_2 alone, but most current debate refers to CO_2 equivalent levels.

[9] See IPCC (2007), Table 3.9, Working Group III Report 'Mitigation of Climate Change'. A probability of 20% is obtained at 378 ppm CO_2 equivalent even using calculations that 'do not take into account the full range of biogeophysical feedbacks that may occur'. The claim that temperature increases should not exceed 2 °C above pre-industrial levels is now routine in official documents (see, e.g., EU, 2005), as well as the media.

[10] Stabilization at 500 ppm CO_2 equivalent yields a temperature increase above 2 °C in the vast majority of scenarios according to the IPCC (2007, Figure 3.38, p. 228), and with a probability of 48–96% depending on the model used, according to Stern (2007, Box 8.1). Possible emissions pathways, and the associated risks, are discussed extensively in the eight articles forming Section VI of Schellnhuber *et al.* (2006).

[11] Stabilization at 500 ppm CO_2 equivalent is thought to require global emissions to be reduced to about 20 gigatonnes by 2050, at which date the global population is projected to be about nine billion (Stern, 2008). The scale of the challenge is illustrated by the fact that the latest edition of Shell's (2008) highly-respected Energy Scenarios implies that 650 ppm CO_2 equivalent is an optimistic outcome, and that 1000 ppm or more is also plausible – see Prinn *et al.* (2008) who analyse a range of reputable emissions scenarios and find that all lie between 550 and 1780 ppm in 2100. The UK has committed to cutting its CO_2 equivalent emissions by 80% by 2050 and to reducing them to between 2.1 and 2.6 tonnes per person (Committee on Climate Change Report, 2008).

The United States, Canada and Australia now each emit well over 20 tonnes of carbon dioxide equivalent per head annually, while the EU and Japan each emit a little above 10 tonnes per head. However, there are signs that these regions may reduce their emissions, because their already-rich populations can afford to worry about their children and grandchildren.

India's per-capita emissions are still below two tonnes of carbon dioxide equivalent, and most of sub-Saharan Africa is well below one tonne of carbon dioxide equivalent. However, China and several other rapidly-developing countries already emit more than six tonnes per head.[12] So the key challenge is: how do we persuade countries like China to more than halve their emissions when they are so focused on economic growth?

The (limited) efficacy of trade policy

The West does have *some* leverage: the French President Nicolas Sarkozy was right to suggest, for example, that the EU should threaten to tax imports from countries that have neither a carbon tax nor a cap-and-trade permit system.[13] If the threat were carried out, and the EU taxed imports' embodied carbon emissions at a rate equal to the price of an EU Allowance, this would be equivalent to introducing these countries' export sectors into the EU's permit system, and would reduce emissions in exactly the same way.

Taxing 'dirty' imports would have other advantages too: it would reduce emitters' incentives to flee the EU for more lax jurisdictions;[14] it would solve any problem of EU firms being disadvantaged relative to non-EU competitors; and it would therefore also greatly weaken the case for giving free permits to firms,[15] thereby enhancing the EU's ability to raise revenues for other climate change mitigation activities. Many economists argue that import taxes undermine free trade. They are

[12] China's 2006 emissions are estimated to be 6.0 tonnes CO_2 equivalent per head. Other large rapidly-developing countries with high emissions include Turkey (5.7 tonnes per head), Mexico (6.4 tonnes per head), South Africa (10.6 tonnes per head), the Russian Federation (15.4 tonnes per head), Brazil (5.4 tonnes per head counting conventionally, plus 7.25 tonnes per head extra due to land use change, i.e., deforestation), and Indonesia (2.7 tonnes per head conventionally, plus 11.5 tonnes per head due to land use change). All the national per-capita emissions figures in this section are Ecofys (2008) estimates for 2006.

[13] See, for example, Barchfield (2008).

[14] This incentive can be exaggerated. It operates mostly in the long run, and is mitigated by the expectation of future carbon regulation in developing countries.

[15] Witness the comment of Sigmar Gabriel, German Environment Minister, in justifying Germany's recent backtracking on the principle of full auctioning of permits: 'As long as European companies are governed by stricter climate protection regulations than their competitors in countries like China, we have to seek to establish special rules' (Bryant *et al.,* 2008). Unless there is substantial foreign competition, giving permits to companies for free represents an unnecessary and improper handout of windfall profits, since consumer prices rise to reflect permits' value, independent of how they are allocated – see Binmore and Klemperer (2002, section 2), Fries (2008), Klemperer (2004; 2008b).

wrong in theory because the absence of any charge for carbon emissions is effectively a subsidy, for which the import taxes simply compensate. And they are also wrong in practice, because we should care more about carbon emissions than about the health of the WTO.

Of course, the practical problems of implementation would be substantial. So we would very much hope never to have to carry out Sarkozy's threat. However, if the EU promised not to tax imports from countries that introduced their own carbon taxes or permit systems for their exports, many countries would likely introduce these measures; the exporting country, rather than the EU, would then collect the revenues from the taxes or permit sales. Moreover, having introduced tax or permit systems for exports (and benefited from the revenues), developing countries might later extend them to other sectors of their economies.

However, even China's substantial export sector represents only around one third of its GDP, although a large proportion of these exports do go to developed-world countries that might plausibly impose an import tax.[16] But while the West can also make other threats, such as to exclude uncooperative countries from international organizations and sporting events, or to encourage consumer boycotts, etc.,[17] the bottom line is that it has only limited influence over the developing world.

China, in particular, seems unlikely to incur significant abatement costs unless it is compensated; this is probably the binding constraint on any global deal (India matters hugely too, of course, but its per-capita emissions are so much lower that it will probably participate in any agreement that China will accept[18]).

The need for more research and development (R&D)

So what conclusions can we draw?

First, whether we like it or not, China (and India and others) will continue to develop nuclear energy. Therefore, unless the West continues to develop it too, the safety, storage and handling issues will be resolved in developing countries, in many of which there is both less democratic accountability than in Europe and the US, and also more pressure to take shortcuts than in richer countries.[19]

Second, China (and India and others) will continue to exploit its enormous coal reserves. Therefore, we urgently need research and development on low-cost Carbon

[16] The developed world (largely EU, USA, Japan, Canada, and Australia) accounts for about five-eighths of China's exports. About 40% of this total goes to the EU, and a similar volume to the USA. See IMF (2008) data for 2007 for the export figures in this paragraph, which are calculated using nominal exchange rates (purchasing power parity rates are substantially different); using nominal values, China's exports 'are on average no more or less carbon-intensive than domestic consumption and investment' (Weber *et al.,* 2008).

[17] See Aldy, Orszag and Stiglitz (2001).

[18] As noted above, India is still below the commonly-suggested target of 2–2.5 tonnes of CO_2 equivalent emissions per head.

[19] Thomas Bruckner *et al.* discuss issues about nuclear energy, and also coal use and CCS, in this volume.

Capture and Storage (CCS) technologies to remove coal plants' emissions. The UK government is right to subsidize a demonstration CCS plant.[20] It should probably subsidize several. It is also right to focus on developing technology that can be retrofitted to traditional plants. China, after all, is building one such plant every five days.

Crucially, however, it will always be cheaper to burn coal (and oil and gas) without CCS than with it. We can encourage developing countries to use CCS through a revised Clean Development Mechanism[21], or – even better – by including these countries in an emissions trading scheme that allocates them enough permits so that they make money by participating. However, Western electorates will only be willing to transfer limited resources to the developing world. There may also be problems monitoring whether CCS technology is being used as claimed, or whether leakage occurs at the storage sites. So CCS alone will not suffice.[22] Only clean energy sources that are cheaper than those currently available are likely to prevent further emissions growth in the developing world.[23]

If large-scale nuclear power is politically unacceptable, substantial investment in clean energy R&D is the only alternative. But the private sector will not do this unaided. Businesses know that when an innovation is sufficiently important, the innovator gets little of the benefit; for example, the developers of drugs for AIDS, and of vaccines for Anthrax and bird flu, were threatened with compulsory licenses in many countries (including in the United States) until they 'voluntarily' licensed their innovations cheaply. The difficulties of getting effective patent protection in the first place (which means any innovator fears being copied, and then forced to compete with imitators), the riskiness of much energy R&D, and the large scale of some of the necessary investments (for example, research into fusion) are further reasons why business is reluctant to undertake the necessary R&D without subsidies.[24]

So it is catastrophic that – as the Stern Report emphasized[25] – public expenditure on energy R&D has been declining in most countries over the last 30 years, and it is shameful that most of Europe spends a much smaller fraction of its GDP on public energy R&D than even the USA and Japan. The UK is one of the worst offenders.

[20] See http://www.berr.gov.uk/whatwedo/energy/sources/sustainable/ccs/ccs-demo/page40961.html.
[21] Diana Liverman discusses various proposals to reform the Clean Development Mechanism in this volume.
[22] A dramatically cheaper 'geo-engineering' solution that sucks CO_2 directly from the sea or the atmosphere (in effect making all existing energy sources clean) might suffice. Here too, public money for R&D is essential for the reasons discussed below.
[23] For example, further development of solar energy may be a particularly promising avenue for the substitution of dirty energy – see the discussion by Walter Kohn in this volume.
[24] Even if these problems did not apply, private enterprise would accomplish less innovation than would be socially optimal, because – as argued above – it is implausible that the international community will make a credible commitment to set a price for greenhouse-gas emissions that equals their full social costs.
[25] See figure 16.3 of the Stern Review (2007), which draws on data from the IEA.

Publicly-funded R&D

Calling for more publicly-funded R&D raises two questions: how should the funds be raised?; and how should they be targeted? Countries should agree that each will support more R&D if others do likewise, thus increasing all countries' incentives to do so. Furthermore, if the EU's cap-and-trade emissions permits were all auctioned, rather than largely given away free,[26] the expected revenues would be at least 30 billion euros per year (based on current carbon prices[27]), and could be greater still if the scheme were expanded to include more sources of emissions.[28] A large fraction of the auction proceeds could and should be pledged to R&D funding.[29] Similar approaches should be taken outside the EU.

Economics has less to say about how best to spend the money.[30] It seems that, even with a clear and apparently relatively easily achievable goal, innovative processes can be highly unpredictable.[31] That suggests distributing the money to a variety of different actors and approaches. Existing funding at both national and EU levels should be increased, especially for basic science (and science teaching).[32] There is probably a greater role for publicly-funded prizes for specific achievements than is now common – witness the success of the XPrizes.[33] The vagueness of these remarks demonstrates an urgent need for research into the economics of innovation!

[26] The permits will mostly be given out to companies free until 2012. (See note 15 for the (lack of) justification for this.) As of December 2008, the EU plans to auction 100 % of permits for electricity generation in 2013, apart from some 'derogations'; it plans to auction 20 % of industrial permits by then, rising to 70 % by 2020, for industries not considered at risk of 'carbon leakage'; see EU (2008).

[27] The number of emissions allowances (EUAs) to be allocated annually (2083 million tonnes CO_2 in the period 2008–2012; see European Commission (2007) and Committee on Climate Change report (2008, p. 151)) multiplied by their market price (EUR 15.30 at mid-December 2008, see http://www.pointcarbon.com) yields about EUR 30 billion. Note, however, that this carbon price is low, relative both to the recent past and to some expectations. (The Committee on Climate Change report (2008, p. 169) uses a carbon price of EUR 51/tCO_2 in 2020 based on 'the assumption of an EU 30 % GHG target and central fossil fuel prices [which] corresponds to the post-global-deal world [it is] expecting and planning for'.)

[28] The EU's Emissions Trading Scheme will cover aviation for the first time from 2012 (European Commission, 2008).

[29] As of December 2008, the EU plans to hypothecate the proceeds from the sales of 200 million emissions allowances in the post-2012 period to the development of CCS and renewable energy sources; see EU (2008). Hypothecation violates economic orthodoxy, of course, but it seems consistent with practical politics in this context.

[30] See, however, the useful discussion in Arrow *et al.* (2008).

[31] For example, Bresnahan (2008) documents that even though e-commerce was an obvious application of the PC, many of the obvious players – including Citibank who invested USD 300 million, and an IBM-Sears-Roebuck-CBS joint-venture – made very large R&D investments in unsuccessful attempts to develop it; e-commerce only eventually arrived after academics-turned-entrepreneurs developed the web browser.

[32] The danger is that special interests will misdirect funding to particular firms, industries, etc. One way to reduce the likelihood of this is to allocate funding through institutions such as the National Science Foundation in the USA, and the Royal Society and the Engineering and Physical Sciences Research Council in the UK.

[33] The prototype is the Ansari X Prize, which offered USD 10 million to the team who could most convincingly pioneer space tourism. This reportedly galvanized substantial private sector investment, which resulted in overcoming the technological challenges (Kalil (2006), p. 5–7, see also Masters and Delbecq (2008)). Further prizes have been announced in genomics, environmentally friendly vehicles, and moon transportation (see http://www.xprize.org). Publicly-funded prizes can also take the form of government purchase guarantees.

Conclusion

More R&D of clean energy is probably the highest priority of all. There are other priorities too, of course. In particular, curbing deforestation is a cheap and cost-effective solution, and has the collateral benefit of preserving biodiversity. But finding a clean energy source that is cheaper than those currently available is the only politically plausible way of curbing growth in developing nations' emissions.

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