14 China's Climate Change Mitigation in International Context:

Issues for Australia and China

Ross Garnaut[1]

Introduction

As the Chinese National Development and Reform Commission (NDRC) observes in its first survey of Chinese climate change policies, 'China is one of the countries most vulnerable to the adverse impact of climate change' (NDRC 2012).

It shares that reality with Australia, for which the extreme heat and bushfires of early 2013 join increasingly common extreme weather events that carry a climate change footprint.

We are two of the most vulnerable countries, but we share vulnerability with the whole of humanity. Extreme weather events have become more common and severe on all continents. Some of the manifestations of more common and severe extreme weather events—for example, as higher global food prices—have been felt everywhere.

The association of extreme weather events with climate change is complicated and confusing, because natural climate variability would anyway have introduced damaging extreme weather events from time to time. We can characterise the way that global warming has affected weather in probabilistic terms by thinking of any particular extreme outcome as being the result of the throwing of a standard dice with six faces. Natural variability would sometimes have generated a one or a six from the roll of the dice, and the average would have settled around three and a half. The early stages of global warming—the increase of a bit below one degree Celsius in average temperatures so far since

1 An earlier version of this chapter was presented as the opening address to the National Development and Reform Commission—State Information Centre Carbon Market Beijing International Workshop, Beijing, 31 January 2013. I am grateful for help from staff members of NDRC, Ian Davies for data for the paper and, Frank Jotzo, Stephen Howes and Ian Davies, for extensive comments. Remaining errors and misjudgements are my own.

the concentrations of greenhouse gases began to build up strongly in the middle of last century—can be represented as having removed the one and replaced it with a seven. In the absence of effective global mitigation, we will replace the two by an eight, and then the three by a nine, with other replacements to follow. When the nine has replaced three, the average outcome from the throw of the dice will become six and a half. What once were one in 200-throw events—an average of six over three throws—will have become average occurrences. We may still throw a four from time to time, but we will now sometimes see a nine, we will never again see a one and, the average outcome will be higher than the most extreme at the beginning.

This is the probabilistic sense in which climate scientists should be understood when they say that no particular extreme event can be said to be caused by global warming, but that extreme events will happen more often and the worst will be more extreme than before.

Climate change takes us into unknown territory for human civilisation.

Human civilisation emerged along the Yellow River and other great river valleys of Eurasia and North Africa over these past 12,000 years of equable temperatures, which scientists have called the Holocene. During this long period, average temperatures varied within a relatively narrow range—a range whose upper limits we are now breaching.

During the Holocene, human civilisation grew through the long accumulation of experience in governing populous states, of knowledge of many kinds, and much sharing of experience through friendly trade and deadly conquest. Sometimes the deadly conquest and trade came together: the Mongol conquerors destroyed state structures and disrupted ordinary life across much of Eurasia. They also brought the experience of the Persian state to China, and facilitated the long-distance trade that took the technological genius of Song China to Europe and provided building blocks for the industrial revolution.

Many people in many states contributed to the knowledge and institutional arrangements that lay the foundations for the emergence in Britain a quarter of a millennium ago of what we now recognise as modern economic growth.

Modern economic growth eventually delivered great bounties to people who embraced it. The bounties came with cost, disruption and pain. The cost and disruption caused hitherto successful societies like old China to be cautious and slow in embracing it. Its uneven distribution across humanity conferred great power upon its early hosts, giving rise to the phenomenon of imperialism, with its manifold iniquities. But, in the end, modern economic growth delivered higher

living standards, more secure food and shelter, healthier and longer lives, more knowledge and experience of life for people who joined it. Modern economic growth came to be wanted by people all over the world.

Over the past quarter century humanity became aware that modern economic growth came with costs that had not been recognised in earlier times. There were incidental or external costs, which had to be managed and contained if they were not to destroy the natural conditions that nurtured the emergence of human civilisation and modern economic growth. One of these costs, the most urgent and dangerous, is human-induced climate change.

Modern economic growth draws on huge amounts of energy. The cheapest and most convenient way of securing much of the necessary energy was by burning fossil fuels. Fossil fuel combustion returned to the atmosphere some of the carbon dioxide that had once made the earth too hot for human life. The natural capture of carbon dioxide from the atmosphere through photosynthesis and its natural sequestration in the earth over hundreds of millions if not billions of years established the climatic conditions under which human civilisation emerged and prospered.

The accumulation of carbon dioxide in the atmosphere raises temperatures on earth. Humans are now creating the climate in which we must make our lives. Humanity has entered the anthropocene.

The brilliant species of which we are members has come an amazing distance in building civilisation over these last 12,000 and, especially, 250 years. The question is whether humanity can manage the external costs of its success. Can humanity manage the anthropocene?

People everywhere want the benefits of modern economic growth, built on high levels of energy use. When I discussed these matters with Deng Xiaoping over a quarter of a century ago, he said that by the middle of the twenty first century the people of China would enjoy the living standards of a middle income country, and that he hoped that they would then be satisfied. These were wise thoughts; but people in China, like people everywhere, are not easily satisfied, and want the best and the most that available technology and resources can give to them.

People everywhere want the living standards that are enjoyed by residents of the high-income economies. But if we seek to achieve those living standards by using energy in the quantities and forms that underpinned modern growth in the economies that are now developed, we will change the earth's climate in ways that are unlikely to be compatible with stable states and sustainable prosperity.

The idea that the finite nature of fossil fuel resources would limit economic growth is an old one. It was a discussed a long time ago by some of the biggest names in economics and the other social sciences. W.S. Jevons discussed the coal-imposed limits to British growth one-and-a-half centuries ago (1865). Max Weber saw the wellsprings of capitalist economic growth running dry when 'the last ton of fossilized coal is burnt' (1905). In his classic 'Conditions of Economic Progress', which pioneered modern quantitative analysis of economic growth, Australian economist Colin Clark opined that we can calculate the likely amount of fossil fuel from the carbon that was once in the atmosphere. 'However, we must not set out to burn them up too fast, even if we do find them, at any rate not faster than the rate at which carbon dioxide can be stored by photosynthesis'. But, Clark added, economic growth itself need not be limited by the availability of fossil fuels: 'there is an abundance of solar energy falling on the earth if we know how to tap it' (1940).

Clark's view that economic growth can be sustained by shifting from fossil to renewable energy has been confirmed by contemporary economic analysis. Elaborate quantitative studies by Nicholas Stern (2007) for the world as a whole and myself (2008) for Australia showed that carbon emissions could be reduced to the low levels necessary to stabilise global temperatures at moderate costs—costs that would slightly slow the growth in living standards in the early decades, and be much lower than the costs of unmitigated climate change after that.

The question of whether we can manage the anthropocene will be answered, yes or no, for humanity as a whole. It will not be yes for people living within some states and no for others. If rising temperatures and changing climate in the anthropocene corrode the physical foundations for human civilisation, there will be no pockets of respite in Hohot or Hobart, Jinan or Geelong, Beijing or Binalong, Xian or Xi Ao.

Stern called the absence of constraints on emissions of climate-changing gases the greatest market failure the world has ever known (2007). The challenge is to have all humans take into account the external effects on global climate of all of the decisions that they take in pursuit of economic growth. Collective action is required through all of humanity.

No state governs the whole of humanity to define the collective action that is required and to enforce rules that correct the market failure. Humanity can manage the anthropocene only if it can build mechanisms within which global collective action can be effective.

The Emergence of a Global Climate Change Regime

China and Australia have been active participants in the international community's work to build a basis for international cooperation on climate change since the beginning at Rio de Janeiro, two decades ago. In 1992, there seemed to be lots of time, and the problem seemed to be overwhelmingly that of excessive emissions from the developed countries.

Those impressions guided the meeting of the United Nations Framework Convention on Climate Change (UNFCCC) in 1997 and the resulting Kyoto Protocol. By then there had been considerable progress in sharing perspectives within a uniquely ambitious and successful effort in international scientific cooperation, through the Intergovernmental Panel on Climate Change. Understandings were reached on which gases would be covered by efforts to reduce emissions, and on how they should be measured. An agreement was reached that all developed countries would accept constraints on emissions, and that there would be penalties for breaches of commitments. There would be opportunities to reduce the costs of mitigation through joint implementation among developed countries (where countries that were falling below their emissions reduction targets would be able to buy entitlements from countries that were reducing emissions more than was required by their targets). There would be opportunities for reducing the costs of mitigation in developed countries through a Clean Development Mechanism (CDM), which would certify carbon reduction 'offsets' generated in developing countries for sale to developed countries. Developing countries undertook to make efforts to reduce emissions; developed countries to contribute funding to these efforts and also to climate change adaptation in developing countries.

The Kyoto arrangements were damaged when the US Congress refused to ratify the agreement to which the US Government was a party. The Republican government under George W. Bush, elected in 2000, announced that it would not seek ratification for the agreement. The Australian Government followed the lead of the United States and continued to do so until policy was reversed in 2007. But both Australia and the United States remained parties to international discussions. Progress was made on some issues in conferences of the UNFCCC in Bali (2007), Copenhagen (2009), Cancun (2010), Durban (2011) and Doha (2012), including on a global objective of holding the human-induced increase in temperatures to two degrees Celsius.

These early efforts in collective action on climate change contained elements of success and failure. It is important to preserve the success (the scientific cooperation, the shared objective, the agreements on how to measure and later

to account for and verify emissions, the mechanisms for international trade in entitlements and for transfers of financial resources to developing countries) while correcting the causes of failure.

Time has passed and times have changed.

We no longer have time: the concentrations of greenhouse gases are already approaching levels that are likely over time to generate two degrees increase in average temperatures. Emissions have grown more rapidly since the turn of the century than was suggested by the most widely used scenarios developed in the 1990s, largely because growth was stronger and more energy-intensive and energy more emissions-intensive than had been anticipated (Garnaut et al. 2009).

If temperature increases are going to be kept to two degrees, there must be an early and large reduction in global emissions trajectories. Global emissions must be reduced by half or more by mid century by putting them on a downward path now. Delays in turning down the trajectories will require an earlier end point for the emissions reductions and a more rapid rate of decline. The practical requirement that all parts of humanity see the distribution of the global mitigation effort as being fair points to movement towards similar per capita emissions entitlements in all countries—at levels more than 90 per cent lower than those present today in developed countries and more than 50 per cent lower than today in China.

In contrast to the world up to the Rio de Janeiro summit, emissions growth in the twenty first century was overwhelmingly concentrated in developing countries. My own calculations on 'business as usual' emissions for the Climate Change Review Update (Garnaut 2011a, 2011b) suggest that, in the absence of policy action to change established trends, developing countries would account for the whole of the increase in global emissions from 2005 to 2030; developed country emissions as a whole were expected to remain steady between 2005 and 2030. In the absence of policy action, China would account for 41 per cent of global emissions in 2030 and developing countries 70 per cent. Whatever weight were given to the requirements of historical responsibility and justice, effective global mitigation would require major and early reductions from business as usual emissions in China and other developing countries.

The Kyoto arrangements had envisaged a comprehensive 'top-down' agreement in which responsibility for constraining emissions would be allocated across countries and enforced internationally. This ideal would provide a firm basis for international trade in entitlements, to allow reductions in emissions to occur where they could be achieved at lowest cost. Such an agreement would provide each country with assurance that others were contributing their fair shares of the global effort, so that its own emissions reductions would be part

of an effective global effort. It would provide each country with assurance that other countries' emissions-intensive industries were gaining no competitive advantage in international markets against its own as a result of differences in mitigation effort.

The international community has learned slowly and painfully that such an agreement is not within reach for the foreseeable future. This reality came within view at Copenhagen in 2009, and crystallised in Cancun in 2010. It was not possible because the major powers, first of all the United States but also China, were willing to bind themselves domestically to strong mitigation outcomes, but not to enter international agreements to the same end. It was not possible because there were no effective sanctions against breaches of commitments—as demonstrated by Canada walking away without penalty from its Kyoto Protocol pledges.

Subsequent developments raise a question about whether a comprehensive 'top-down' agreement is even desirable. In anticipation of a legally binding agreement, governments settle into negotiating mode and seek to minimise commitments. By contrast, when considering a domestic commitment, governments are prepared to look more openly at the realistic boundaries of action and to go further in defining mitigation targets.

A different approach to setting national targets began to emerge at Copenhagen, took firm shape at Cancun and was elaborated in subsequent UNFCCC meetings in Durban and Doha.

The new approach carries some important features over from the early international discussions. The scientific cooperation remains centrally important to the collective effort. The two-degree objective, mechanisms for measurement and verification of emissions, and instruments for international trade in entitlements have been developed or strengthened. Ideas about mechanisms for transferring resources for mitigation and adaptation from developed to developing countries have been given substantive shape (although still little money). It must be said that additional steps need to be taken on verification of emissions: while a case can be made for developing country mitigation targets to be expressed in different ways from developed country targets (intensity rather than absolute reductions), there is no case for differentiation in measurement and verification.

The biggest departure from the old regime is in the setting of country targets for constraining emissions. It has been accepted that substantial developing countries will make commitments to constrain emissions, in the form of reductions in emissions intensity or 'business as usual' emissions. (Intensity targets are strongly preferred to business as usual, as they are capable

of objective and unambiguous calculation). It is accepted, if only by default, that these and developed-country commitments to absolute reductions in emissions are voluntary and represent serious domestic undertakings and are not binding under international law. The voluntary targets are set domestically rather than within a comprehensive international agreement. The pressures to make them ambitious come from domestic politics and review and commentary from other countries—a process that is known as 'pledge and review'.

I describe the new process as 'concerted unilateral mitigation'.

It is a feature of the Kyoto arrangements carried over into the concerted unilateral mitigation regime that each country is free to use whatever instruments it chooses in meeting its targets. It is free to acquit its commitments through the purchase of international abatement to the extent that it chooses, or not at all. It is free to introduce carbon pricing in the form of an emissions trading system or a carbon tax, or not at all. Whether or not it places a price on carbon, it can choose to regulate emissions-intensive activities and subsidise low-emissions substitutes to the extent that it chooses. International comparisons of mitigation effort are made in terms of the outcomes in reductions in emissions below defined baselines, and not in terms of how the emissions reductions are achieved.

For concerted unilateral mitigation to be effective, one major gap in the international regime needs to be filled. The regime needs some framework for guiding assessments of the level of mitigation in each country that amounts to a fair share of an international effort to achieve the agreed global effort. It would be useful and probably necessary for heads of governments committed to strong global mitigation outcomes to appoint an expert group to develop such a framework for allocating the global effort among countries. Within the context of concerted unilateral mitigation, each country would be free to accept or reject guidance provided by such a framework. The framework would become a focus of international review of each country's effort, and evolve over time in response to discussion and experience.

The Durban conference of the UNFCCC in late 2011 agreed to launch 'a process to develop a protocol, another legal instrument or an agreed outcome with legal force'. The process, legal instrument or agreed outcome would be settled by 2015 in the Conference of the Parties in Paris, and come into effect in 2020. Developed and developing countries would all accept obligations, although the form of those obligations could vary across countries.

The Durban decision was sometimes interpreted as a commitment again to seek a binding, top-down agreement, although the words allow other interpretations. At least there is no suggestion that we should return to seeking comprehensive agreement on the allocation of the required global mitigation

effort across countries. While there would be advantages in an internationally binding agreement, if it were possible to achieve one without reducing mitigation ambition, the practical barriers to a good binding agreement remain as strong as they were at Copenhagen. It is important that we do not allow the search for excellent form to distract the international community from grasping immediate prospects for excellent substance.

To conclude the discussion of the evolution of the global climate change regime, we should acknowledge that trade in emissions entitlements has struck some large practical problems. Within the European emissions trading system, the many regulatory and fiscal interventions are forcing much larger reductions in emissions than carbon pricing. These, together with slow growth in economic activity and the realisation of unexpected opportunities for low-cost abatement, have caused permit prices to fall to levels that are well below the economic cost of emissions and the value of abatement. The low prices raise questions about the effectiveness of the emissions trading system. Although controlled in quantum, use of offsets at very low prices from the CDM has pushed prices even lower. Low European and CDM prices would, if uncorrected, introduce low prices into other emissions trading systems with which Europe is linked, notably Australia from 2015. Already New Zealand's emissions trading scheme has prices close to zero through allowing unlimited access to credits from the CDM.

It is understood by economists that broadly based carbon pricing achieves more carbon emissions reduction at similar cost, or similar abatement at lower cost, than large numbers of separate regulatory and fiscal interventions. Considerable emissions reductions have been achieved in recent years in many countries through regulatory and differentiated fiscal interventions. The cost advantages of general carbon pricing become more important, however, as mitigation targets become more ambitious, and are likely to be essential to achieving the reductions in emissions that will be necessary to achieve the agreed global objective. The contemporary problems of uneconomically low prices in domestic and international trading schemes can therefore be seen as a threat to achievement of long-term global mitigation goals. A tightening of emissions reduction targets is necessary to restore prices that relate appropriately to the cost and value of abatement in a world that is meeting its emissions reduction targets.

The CDM has emerged as the most important locus for international trade in carbon units and, for a number of years, contributed substantially to incentives for investment in emissions reduction in developing countries. The NDRC has recently reported that to August 2012, Chinese certified emissions reduction under the CDM had reached 730 million tonnes per annum (NDRC 2012), a bit over half of the global total.

As analysed in the recent report of an independent review panel, the CDM is experiencing chronic oversupply of abatement units. Prices have fallen to levels that barely cover transaction costs. With recent and prospective reforms, the CDM is a legitimate offset mechanism with a potentially valuable place in a global system of climate change mitigation (CDM Policy Dialogue 2012). The review panel concluded that a major tightening of emissions reduction targets and widening of access on the demand side would be necessary to correct the chronic oversupply. I would suggest as well a tightening of access on the abatement supply side, with only least developed countries having unconditional access. Other developing countries would have access if they accepted domestically binding emissions constraints and were living within those constraints without double counting of abatement for which CDM credits had been awarded. If this approach were adopted by the international community, international mechanisms would need to be developed (perhaps through the established arrangements for joint implementation) to monitor double counting of emissions.

The Cancun Pledges

Within the framework of concerted unilateral mitigation, all substantial economies placed pledges before the international community that they would reduce emissions below business as usual. The sum of the pledges represented a marked departure from established emissions trajectories. At the same time, they were no more than a small first step towards achieving the reductions in emissions that would be necessary to achieve agreed climate change objectives.

The United States pledge represented a large departure from earlier perspectives. President Bush told a meeting of representatives of large economies in 2007 that US emissions would continue to rise to a peak in 2025. The Cancun pledge was for emissions to fall from 2005 levels by 17 per cent by 2020, corresponding to a 16 per cent fall from 2000.

Canada pledged to match a binding commitment by the United States—a substantial undertaking unless the Canadian Government had it in mind to annul it by saying that the US pledge was not binding even if it were being met.

Some of the pledges contained conditional and unconditional elements—the latter being triggered if other countries took strong action. The European Union pledged to increase its emissions reductions from 20 to 30 per cent (both based on 1990) in the context of strong international action.

The Australian pledge was unconditionally to reduce emissions by 5 per cent on 2000 levels by 2020, and to increase the reduction to as much as a 25 per cent in the context of strong international action. The unconditional commitment represented a sharp break in the trajectory of Australian emissions growth, influenced as it was by the developed world's most rapid growth in population and economic activity and exceptionally rapid expansion of emissions-intensive resource export industries. In 2011, the Australian Department of Climate Change and Energy Efficiency estimated that existing policy, without the new policies legislated in 2011, would see Australian emissions rise by 24 per cent.

The Chinese target was to reduce the emissions intensity of economic output by between 40 and 45 per cent between 2005 and 2020. This represented the largest departure from business as usual in terms of tonnes of emissions avoided. It could have had a galvanising effect on the Copenhagen meeting at which it was revealed to the international community. That its importance was not noticed and brought to account was a failure of diplomacy in China and many other countries.

Other developing countries made pledges amounting to major changes from business as usual trajectories, with the Brazilian and Indonesian pledges being noteworthy.

The other large developing country, India, made commitments to reductions in emissions intensity that were more modest, but were accompanied by statements that India would never allow per capita emissions to exceed those of developed countries (Planning Commission Government of India 2011). This formulation has the potential to be a powerful instrument of global mitigation in the context of strong action and rapid reduction in emissions across the developed world. It could be usefully incorporated into a global framework for assessing the reasonableness of national contributions to a global mitigation effort.

The various pledges within the context of concerted unilateral mitigation added up to a much larger departure from established emissions trajectories than the notionally binding commitments at Kyoto. The pledges, however, left global emissions on trajectories that were far too high for achievement of the two-degrees objective, unless much more ambitious additional commitments were made for the periods from 2015 and 2020.

Of course, one cannot say now what the Cancun pledges mean for the containment of global warming, as they say nothing about what happens after 2020, and do not allow for the possibility of concerted raising of ambition for what is left of the period before 2020.

Encouraging Progress

There is good and bad news in the story of humanity's struggle to find a basis for effective collective action on climate mitigation. The early news was never going to be all good on an issue as complex, difficult and new to the international community as this one.

The best news is of immense importance: emissions generally seem to be on paths to meet or exceed the Cancun targets. They are on track to meet or exceed the pledges even in the cases of China and the United States—the world's biggest emitters of greenhouse gases, the largest and most influential economies, and the pledges of which represent dramatic reductions in established trajectories. Moreover, the achievement of current pledges is being achieved at less cost than was anticipated by most analysts. Early and widely based progress at surprisingly low cost establishes sound foundations for a large and early increase in national mitigation ambition.

Far from reaching a peak in emissions in 2025, as Bush foreshadowed in 2007, it now seems that US emissions reached their highest level in the year in which Bush was speaking, and have been declining since then. Some have suggested that a decline in economic activity in and following the Great Crash of 2008 has dragged emissions down; the reality is that US output is now higher than in 2007.

Two recent private US studies, by Resources for the Future and the National Resource Defense Counsel, have concluded that the United States is on course to meet its emissions reduction targets despite the defeat in the Congress of President Obama's proposal for an emissions trading scheme (Scientific American 2012; National Resource Defense Counsel 2012). An emissions trading scheme would have allowed the same reduction of emissions at lower cost, but higher cost means can still achieve large reductions in emissions. The Resources for the Future studies attribute 10.5 percentage points of emissions reduction to US federal regulation of mobile and stationery energy, 2.5 per cent to state-level regulation and emissions trading schemes and 3.3 per cent to the expanded availability of cheap gas and other energy market developments. Since 2009, the US Government has invested heavily in research and development for new, low-emissions technologies, and this can be expected to be reflected in new opportunities for emissions reductions over time. Low gas prices—the result of combining tight restrictions on exports with large expansions of reserves—are becoming increasingly important over time, leading to the decommissioning of much coal-based generation capacity.

Europe is already close to achieving its Cancun objectives for emissions reductions by 2020. Slow economic growth has subdued demand for emissions-intensive goods and services, but the extent of reduction and the low price of abatement in the emissions trading scheme suggest that emissions reductions have been achieved at lower cost than had been anticipated.

In Japan, as in Europe, economic stagnation has contributed to over-performance on emissions reduction goals, despite the setback to low emissions energy with the 2011 nuclear breakdown at Fukushima. Tokyo's introduction of emissions trading arrangements has been accompanied by especially rapid reductions in emissions, which, in turn, have generated extremely low emissions entitlement prices (Rudolph and Kawakatsu 2012).

In Australia, too, emissions growth has been well below anticipated levels over recent years, tending around zero, despite the continuation of robust expansion of population, output and emissions-intensive resource investment for export. In the electricity sector, stagnant or declining demand has intersected with increased renewable energy production forced by the renewable energy target to cause faster decarbonisation than had been suggested in the official estimates. The introduction of carbon pricing from July 2012 and the use of part of the associated revenue to support renewable energy innovation will extend the reduction in emissions. Preliminary data suggest that emissions from electricity generation in the first six months of the emissions trading scheme are over eight per cent lower than in the corresponding period of the previous year, with slowing demand growth, the renewable energy target and the emissions trading scheme contributing to reductions.

China's 12th five-year plan, 2011–2015, embodies far-reaching measures to constrain emissions within the intensity targets which the Chinese Government has communicated to the international community. In 2011, the first year of the new plan, emissions continued to grow strongly. This was discouraging for the international mitigation effort. The emissions reductions policies bit more deeply from 2012 and, together with economically driven structural change, changed the emissions trajectory in 2012, to an extent that over-performance against the pledge seems possible and strengthening of the pledges feasible in the context of increased global effort.

Within the electricity sector, accounting for over 44 per cent of China's emissions in 2010 (IEA, 2012), demand growth slowed to 5.7 per cent in 2012 after demand doubled over the previous decade. The slower growth in demand was in response to energy efficiency and structural policies as well as a moderate easing of output growth (GDP growth 7.9 per cent through the course of 2012). The energy efficiency policies and structural change are likely to keep electricity

demand growth much lower than in the first decade of the 21st century, and bring within reach the 3.5 per cent annual increase in primary energy consumption necessary to achieve the electricity targets of the 2011–2015 plan.

A Chinese State Council decision added detail to energy plans in early 2013 (Xinhua 2013). Annual primary energy consumption 2011–2015 would be held to 4.3 per cent per annum compared with 6.6 per cent through the preceding five years. This corresponds to about 3.5 per cent over the next three years. Annual coal consumption will be capped in 2015. Given the constraints on reducing coal consumption in steel-making and other industrial activities, this implies some decline in coal combustion for electricity generation.

Table 14.1 describes the remarkable change in the extent and composition of electric energy growth in 2012.

Table 14.1 China: power generation 2011 and 2012

	2011	2012	% increase
Total power generation (TWh)	4,692	4,959	5.7
thermal	3,900	3,925	0.6
hydro	668	800	19.7
nuclear	87	102	17.2
wind	74	100	35.8
Other	n/a	32	n/a

Source: NDRC/State Information Center, based on information from the National Energy Administration, January 2013.

Note: 'Other' is solar, biomass and geothermal. There was a large percentage increase in 2012 from a low base (more than 100 per cent for solar photovoltaic), but data on the composition of 'Other' are not available for 2011. Note that the components for 2011 exceed the total by a small percentage, but, at the time of writing, the author has no explanation for this anomaly.

Total electricity demand growth slowed to 5.7 per cent in 2012. While early data for 2012 contain some inconsistencies and are subject to revision, they are striking and encouraging. There seems to have been almost no growth in thermal power generation. Output of all low-emissions energy ('clean' energy in the Xinhua terminology) sources of electricity grew rapidly: hydro-electric by 19.7 per cent; nuclear by 17.2 per cent; wind by 35.8 per cent. Solar increased much more rapidly still from a low base. While hydro-electric power generation is affected by climatic conditions which were unfavourable in 2011 and favourable in 2012, it will fluctuate around a rising trend. Nuclear power generation is likely to continue to rapidly increase its share of power generation and wind and solar to do so at an even more rapid rate.

Within thermal power generation, a number of factors led to reductions in greenhouse gas emissions per unit of electricity. A number of Chinese policies will contribute to maintaining the new momentum in reducing emissions from thermal generation that became apparent in 2012. There is still some way to go in replacing high-emissions coal generation in small, inefficient generators with ultra-supercritical plants operating at the world's efficiency frontiers: the International Energy Agency (IEA) refers to 68 GW of small (less than 100 MW) and 138 GW of medium (100–300 MW) of coal-generating capacity remaining in 2010, which is slated for replacement (IEA 2012). The replacement of inefficient small by efficient large plants reduces both coal use and emissions per unit of electricity output. The careful research of Mai (2013) shows that the small for large scheme will lead to reductions of between one and two per cent per annum in thermal coal use in the years immediately ahead.

Policy is focused on substantially increasing the natural and unconventional gas share of thermal power generation from the current low base. The State Council sees the gas share of primary energy consumption doubling to 7.5 per cent by 2020 (Xinhua 2013).

China is investing more heavily than any other country in technological development for capture and storage of carbon dioxide waste from fossil fuel combustion. Deregulation of electricity and coal prices in 2013, accompanied by removal of coal transport subsidies, are likely to contribute to easing in electricity demand and to increasing costs of supply from the coal sector. Major investment in high-voltage, long-distance transmission and in pumped hydro storage is leading to more complete utilisation of intermittent renewable energy capacity, and to expanding options for new investment in renewables. The 12th five-year plan greatly increases financial commitments to energy efficiency and for innovation in low-emissions technologies, including in the electricity sector.

The electricity supply and demand developments seem to have stopped growth in emissions from combustion of coal in electricity generation in 2012. This is a dramatic break from established trends, of historic importance in global terms. It takes us way outside the conventional wisdom on development of the Chinese energy market. The IEA had assessed that China would need to increase coal-based generation capacity from 710 GW in 2010 to 1190 GW in 2020, with total emissions rising despite continued replacement of economically and environmentally inefficient plants by ultra supercritical capacity (IEA 2012). That assessment is obsolete.

In more than three decades of work on Chinese economic growth and structural change in the reform era, I have become accustomed to Chinese and foreign observers alike underestimating the capacity of China's economy to

respond quickly and powerfully to incentives and to opportunity. The current energy market adjustment seems to be another case of underestimation of the Chinese economy's capacity for rapid transformation in the reform era. Of course, the outcome will depend on the policy that emerges from continuing debates and political contests within China: in the Chinese political system, as in its counterparts in the West, the success of the public interest in shaping policy is qualified by pressure from vested interests.

The strengthening of policies and actions to change the trajectory of China's greenhouse gas emissions extends over all major sectors.

Industrial emissions, which are largest in steel production, are experiencing much slower growth as a result of policy-enhanced slowing in the rate of growth of heavy industry, and by innovation to reduce emissions intensity. Forced closure of inefficient plants (32 million tonnes of steel capacity alongside 8,000 MW of coal electricity generation in 2011 alone (NDRC 2012)), higher costs of electricity and other inputs, export taxes and restriction of investment in new capacity have slowed expansion in energy- and emissions-intensive activities. The goal articulated in the 12th five-year plan to reduce the energy intensity of steel production by a percentage point per annum is a realistic extrapolation of recent trends.

In transport, the heavy investment over the past decade in inter-city and intra-city rail will ease somewhat the growth of automobile traffic from what it would have been. Within the automotive sector, ambitious official targets for electrification are being strongly supported by a range of policies (NDRC, 2012). The combination of rapid expansion of public transport led by rail, automotive electrification and decarbonisation of the electricity sector are likely to add up to unexpectedly early peaking of emissions from the transport sector.

China's and Australia's International Roles

Within concerted unilateral mitigation, it is important for each country to make pledges that are recognised as a fair share in a global mitigation effort, and to deliver on those commitments.

China matters because of its importance as a source of emissions and its economic and strategic weight. China also matters because it is likely to have comparative advantage in mass production of capital goods embodying low-emissions technologies: large-scale production of photovoltaic units in China has lowered the cost of solar power generation all over the world, and similar developments are likely in other technologies.

China has become one of the world's main sources of direct foreign investment. Direct investments in transmission by China's State Grid Corporation have greatly reduced the costs of modernising transmission systems in the Philippines, Portugal and Brazil in recent years, and is set to become important in Australia.

Both Australia and China can contribute to innovation in the low-emissions industries. Australian research institutions, notably Electrical Engineering at the University of New South Wales, have been at the forefront of applied research in solar technologies, the commercialisation of which has been concentrated in Chinese enterprises. Australia is disproportionately represented in innovation in the biological sciences with relevance to emissions reduction.

Australia and China share a strong interest in the nurturing of opportunities for international trade in emissions entitlements. Each has comparative advantage in emissions-intensive activities: China in manufacturing, Australia in tradeable energy. Large-scale exports of emissions-intensive products will tend over time to make both Australia and China relatively large sources of emissions per person. It is economically desirable for these two countries, and for the world as a whole, that they are able to maintain high levels of exports of emissions-intensive goods, and to meet part of their abatement responsibilities by buying emissions entitlements from other countries.

How can we build on these shared interests and favourable circumstances to improve the chances that humanity is able to manage the anthropocene?

First, we can share views on all aspects of the climate change challenge. These include views on industrial transformation—including China's experience in upgrading transmission grids to reduce energy losses, to connect energy resources to distant centres of demand, and to integrate intermittent electricity sources more efficiency into the major grids. They include, as well, experience with mitigation policies (Jotzo 2013), and the sharing of analytical insights.

Second, we can together take the lead in initiating an independent global analysis of what constitutes a 'fair share' of the strong global mitigation effort that will be required to meet the two-degrees objective. China and Australia can be among the countries that work together to provide an essential component of successful concerted unilateral mitigation.

Third, we can work together to strengthen the pledges that the substantial economies have made to reduce emissions, and to ensure that international trade in entitlements remains a legitimate means of meeting emissions reduction pledges.

The third area of cooperation is especially important, as the international community faces decisions over the next two years which will determine whether the two-degrees objective remains within reach. This chapter has explained that marked strengthening of pledges for 2020, and the adoption at Paris in 2015 of strong targets for the period after 2020, are essential to achieve the two-degrees objective, to raise prices of traded entitlements to economically and environmentally rational levels, and to underwrite a continuing role for domestic and international trade in entitlements.

It is common for commentaries to focus on the failures of international cooperation on climate change. This chapter has drawn attention to some successes that could become the launching pad of a strong international effort to bring within reach the agreed objective of holding temperature increases to two degrees.

Conclusions

This chapter has drawn attention to the fact that the major economies including China, the United States, the European Union and Japan (despite the setback to nuclear energy at Fukushima) and Australia are making unexpectedly rapid early progress towards realising their pledges to the international community. Reducing emissions is proving to be less costly and disruptive than had been anticipated by expert observers.

The chapter has noted the importance of international trade in emissions entitlements in reducing the costs of mitigation for the world as a whole. One weak point in contemporary collective action on climate change is the low prices for carbon units in the European Union and other emissions trading systems, and in the CDM. The continuation of low prices would discredit international trade as well as domestic emissions trading systems. The low prices themselves reflect the unexpectedly low cost of reducing emissions.

Of course, there is no problem with low prices if they emerge from targets that are strong enough to achieve the agreed global mitigation objectives. But we are currently far from that point. Current targets fall well short of those necessary to achieve global objectives. In these circumstances, the remedy for prices that are well below the cost and value of optimal abatement is the same as the remedy for a global mitigation effort that currently falls well short of the requirements of the two-degrees objective: an early tightening of targets.

The recent rapid progress towards announced targets on emissions reductions in many countries, and the revelation that costs of reducing emissions have been unexpectedly low, together provide the foundations for an

early tightening of announced targets in developed and developing countries alike. An international climate change system built around concerted unilateral mitigation provides a favourable context for China and Australia to play their parts in a renewed international effort to achieve the agreed objective of the international community.

References

CDM Policy Dialogue, 2012, *Climate Change, Carbon Markets and the CDM: A Call To Action*, Report of the High-Level Panel on the CDM Policy Dialogue, September 2012, http://www.cdmpolicydialogue.org/report

Clark, C., 1940, *Conditions of Economic Progress*, Macmillan, London.

Du, Juan, 2013,, 'Major Coal Firms Cut Production as Prices Fall, Stocks Rise', *China Daily*, 10 May.

Garnaut, R., 2008, *The Garnaut Climate Change Review: Final Report*, Cambridge University Press, Melbourne.

——, 2011a, 'Garnaut Climate Change Review Update Paper 3: Global Emissions Trends', paper presented to Australian Agricultural and Resource Economic Society Annual Conference, Melbourne, http://www.garnautreview.org.au/update-2011/update-papers/up3-global-emissions-trends.pdf

——, 2011b, *The Garnaut Review 2011: Australia in the Global Response to Climate Change*, Cambridge University Press, Melbourne.

Garnaut, R., Jotzo, F., Howes, S. & Sheehan, P., 2009, 'The Implications of Rapid Development for Emissions and Climate Change Mitigation', in D. Helm and C. Hepburn (eds), *The Economics and Policy of Climate Change*, Oxford University Press, pp. 81–106.

International Energy Agency (IEA), 2012, *Policy Options for Low-Carbon Power Generation in China*, http://www.iea.org/publications/insights/name,32266,en.html

Jevons, W. S., 1865, *The Coal Question: An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of our Coal Mines*, Macmillan and Co., London.

Jotzo, F., 2013 'Emissions Trading in China—Principles, and Lessons from International Practice' in *Market Mechanisms for China's Carbon Emission Reductions: Economics, Modelling and International Experience,* China State Information Center, National Development and Reform Commission, Beijing.

Mai, Yinhua and Shanghao, Feng, 2013, 'Increasing China's Coal-fired Power Generation efficiency: The Impact on Carbon Intensity and the Broader Chinese Economy to 2020', paper to State Information Centre (SIC) and National Development and Reform Commission (NDRC) Workshop, Beijing.

National Development and Reform Commission (NDRC), 2012, *China's Policies and Actions for Addressing Climate Change*, Beijing, November, http://qhs.ndrc.gov.cn/zcfg/W020121122588539459161.pdf

National Resources Defense Council (NRDC), 2012, *Closer than You Think: Latest U.S. CO2 Pollution Data and Forecasts Show Target Within Reach*, July, New York, http://www.nrdc.org/globalwarming/closer-than-you-think-ib.asp

Planning Commission Government of India, 2011, *Interim Report of the Expert Group on Low Carbon Strategies for Inclusive Growth*, New Delhi, http://planningcommission.nic.in/reports/genrep/Inter_Exp.pdf

Rudolph, S. & Kawakatsu, T., 2012, 'Tokyo's Greenhouse Gas Emissions Trading Scheme: A Model for Sustainable Megacity Carbon Markets', Joint Discussion Paper Series in Economics, Universities of Aachen, Gieben, Gottingen, Kassel, Marburg, Siegen.

Scientific American, 2012, *U.S. May Come Close to 2020 Greenhouse Gas Emission Target*, http://www.scientificamerican.com/article.cfm?id=us-may-come-close-to-2020-greenhouse-gas-emission-target

Stern, N., 2007, *The Economics of Climate Change: The Stern Review*, Cambridge University Press.

Weber, M., 1905, *The Protestant Ethic and the Spirit of Capitalism*, T. Parsons (trans., 1930), Dover Publications Inc, New York.

Xinhua, 2013, 'China Sets Slower Energy Consumption Targets', 25 January http://news.xinhuanet.com/english/china/2013-01/24/c_132125842.htm