China, Copenhagen and Beyond

The Global Necessity of a Sustainable Energy Future for China

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Preface

All eyes are focused on China this year as the international climate treaty negotiations in Copenhagen draw near. The European Union has taken the lead in setting its targets for the climate change agenda, while the Obama administration has declared new ambitious goals in this field, reversing previous policy in the United States. As for China, it is considered by many to be the deal maker or breaker in the efforts of reaching a multi-lateral agreement on the reduction of greenhouse gases, in particular since China's involvement is considered to be a prerequisite for the participation of the U.S. in any such action plan. Hence, China is perceived as the key to a successful conclusion of the negotiations and its negotiating stance is followed closely. This paper will offer some perspective as to what we can expect from the negotiations.

China has recently become the world's largest emitter of greenhouse gases. A further rise in emissions seems an inevitable consequence of its ongoing economic development, which is improving the standard of living of its massive population. Moreover, China's coal-based energy system is aggravating the environmental impact of its skyrocketing energy consumption. The participation of China in a global action plan is vital if one considers the emissions reductions that are needed in order to avoid large-scale climate change as projected by the Intergovernmental Panel on Climate Change of the United Nations. The Chinese government has acknowledged the serious threat that climate change poses for the world and has initiated policies to limit emissions and reshape its energy system in a more sustainable fashion. Even though the Chinese government has rejected the call for binding commitments on emissions reductions, it recognizes that action in China is indispensable in tackling this global problem. More importantly, China's surging energy consumption and energy security concerns also point out the need for a sustainable energy system in China.

This publication aims to analyse China's position in the international climate treaty negotiations, with China's current energy and emissions trends being the essential background. The research will focus on what is considered to be domestically achievable in China as well as the global geopolitical circumstances that are influencing the negotiations, which together will decide the outcome of the discussions and the further direction of the climate change regime beyond Copenhagen.

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Executive Summary

The climate treaty negotiations seeking a greater involvement of China in efforts to curb global greenhouse gas emissions are set against a grim background. Chinese emissions have been growing at an astonishing pace, surpassing all projections. Growth even accelerated in recent years and carbon dioxide emissions arising from fossil fuel use increased with almost 80 percent between 2000 and 2006. Most business-as-usual scenarios see Chinese emissions at least doubling before 2030 is reached, estimating that they will account for almost one-third of global annual emissions by that time.

China has a crucial role in addressing climate change not only because it has become the world's largest emitter of greenhouse gases, but also because it offers a tremendous potential for mitigating climate change. The extremely rapid growth in sectors such as power generation, housing and transportation is laying the basis for energy consumption and emissions levels for the coming decades. While this development is taking place, there is still a chance to guide it towards a more low-carbon trajectory at a relatively low cost. Yet this window of opportunity is rapidly closing.

To achieve a low-carbon energy future for China, two major tasks stand out. The first is to decrease the high energy intensity of the Chinese economy, by means of energy conservation and energy efficiency improvements. The second is to limit the use of coal, the most carbon-intensive fossil fuel, which currently supplies 70 percent of China's primary energy. Renewable energy sources, nuclear power, coal-to-gas fuel switching, and the deployment of new technologies will all be vital to succeed in decoupling China's rising energy demand from its emissions levels.

In fact, the Chinese government is making a strong effort in many of these fields, driven by increasing concerns over energy security and the negative impact of coal use on public health and environment. There is a strong economic rationale behind the supportive policies as well, as an increasing number of Chinese companies is active in the field of low-carbon technologies, both for export and domestic use.

Some of the most noteworthy developments are the following:

- On energy efficiency, the current Five Year Plan includes a 20 percent energy intensity reduction target for 2010 that is estimated to save 1.5 billion tons of CO_2—more than four times the amount of CO_2-equivalent reduced by the EU-15 under its Kyoto target. In recent years, efficiency standards have been improved in a wide range of sectors. Requirements for vehicle fuel efficiency for instance, are more strict than those in the United States.
- China aims to double the share of renewable energy in its primary energy consumption to 15 percent by 2020. There is strong government support for renewables through fiscal policy, feed-in tariffs and a renewable portfolio standard obliging power companies to develop and purchase renewable energy.

- The Chinese wind energy market has become one of the largest in the world, with installed capacity doubling for four years in a row. Benefiting from government policy, domestic wind turbine manufacturers have sprung up and reached a market share of over 50 percent in just a few years time. The original target for wind capacity of 30 GW in 2020 might be raised to 100 GW or even 150 GW.
- Chinese companies involved in the manufacturing of solar photovoltaics have claimed a significant share of global production and are expanding fast. Although this industry is almost fully export-oriented, a domestic solar power market is being promoted. Implementing solar hot water has been very successful.
- Nuclear power is rapidly expanding and China is actively building a domestic industry capable of both designing and constructing third-generation nuclear power plants. At the moment, around one third of all nuclear power plants under construction worldwide are being built in China.
- In addition, China is becoming increasingly competitive in technologies such as energy-efficient lighting, electric vehicles, coal gasification and advanced grid technology, which all might contribute to lowering emissions.

These trends show that China is certainly preparing itself for a future in which it will be less dependent upon fossil fuels. Many developments are aligned with the objective of reducing greenhouse gas emissions, yet the relevant factor for climate change is the speed at which this transition is taking place. The key challenge for an international treaty on climate change is to ensure that this process will be accelerated.

Despite the domestic effort, China has been very consistent in its refusal to commit to binding emissions targets in the international climate treaty negotiations. The current geopolitical setting makes it unlikely that China will deviate from this standpoint in Copenhagen, as many developed countries are having difficulties to agree on stringent targets themselves. For the moment, the entrenched division between Annex-I and non-Annex-I countries is in China's advantage, and the failure of many Annex-I countries to fulfil their promises on reducing emissions has eased political pressure on the developing countries to increase their efforts.

However, in the case of parties reaching agreement and pressure mounting for China to make some commitment, China still has a trump card to play. Its current target for energy intensity can easily be translated in an *emission intensity* target, which would signify a lowering of emissions levels per unit of GDP. Such a 'soft' target could be a very suitable compromise in the negotiations. Without yielding too much, China would be able to gain the prestige of being a dealmaker, fitting in with its foreign policy of portraying itself as a 'responsible stakeholder' in the world political system.

1

Climate change and China

The threat of climate change has been termed the biggest challenge facing mankind in modern history. The Intergovernmental Panel on Climate Change set up by the United Nations has indicated that the concentration of greenhouse gases in the atmosphere will need to be quickly stabilised and reduced in order to avoid large-scale climate change. This chapter will show that the participation of China, having recently emerged as the world's largest greenhouse gas emitter, will be essential to the success of this global effort. However, while this would require China to start limiting its greenhouse gas emissions, the growth of its emissions has accelerated in the past few years, making a complete turn-around of this trend ever more unlikely. In fact, according to authoritative forecasts China's emissions will account for nearly half of the growth in global carbon dioxide emissions between now and 2030.[1]

This is the fundamental problem that will be analysed in this chapter. We will look at China's surging greenhouse gas emissions and put these in an international perspective. It will lead us to a discussion of China's current energy system, its historical development, recent trends and the repercussions of energy-related greenhouse gas emissions. When considering the impact of China's energy use on emissions levels, the crux of the matter is the heavy reliance of China on coal in its primary energy consumption. The key question is what role it will play in China's future.

1.1 Greenhouse gas emissions and global warming

To support policy decision-making on climate change, the United Nations created the Intergovernmental Panel on Climate Change (IPCC) in 1988 from a large body of international scientists. This panel has the assignment to supply objective scientific evidence evaluating the risks associated with climate change, with a focus on the possible effects and mitigation options. Since 1990 it has issued several *Assessment Reports* analysing the most recent developments in climate change research. These reports formed the scientific foundation that underlay the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and the Kyoto Protocol in 1997.

The IPCC Fourth Assessment Report

According to the most recent IPCC Fourth Assessment Report, published in 2007, the current warming of the climate system is unequivocal and very likely caused by the observed increase in anthropogenic greenhouse gas concentrations.[2] Global surface temperature increased by 0.74 ˚C in the century between 1906 and 2005, and the

[1] Energy Information Administration, U.S. Department of Energy, *Emissions of Greenhouse Gases Report*, 3 December 2008. Retrieved at http://www.eia.doe.gov/oiaf/1605/ggrpt/ on 2 Feb 2009.

[2] IPCC, *Fourth Assessment Report. Climate Change 2007 – Synthesis Report, Summary for Policymakers*, 2007, p. 5. Retrieved at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf on 21 April 2009.

increase is accelerating according to all measurements. Eleven of the past twelve years (1996-2006) rank among the twelve warmest years ever recorded. Global average sea level has risen since 1961 at an average rate of 1.8 mm/yr but has accelerated lately, with the average annual increase since 1993 standing at 3.1 mm. Glaciers around the world are receding, and Arctic sea ice extent has shrunk by 2.7 percent per decade since 1978.[3]

Box 1. Global warming – the theory behind it

Global warming is caused by several greenhouse gases, which prevent reflected radiation from the earth's surface from leaving the atmosphere. This radiation is held inside the system in the form of heat, thus contributing to the warming of the overall temperature on Earth. As these gases linger in the atmosphere for periods ranging from a few years to hundreds of years, the impact of greenhouse gases is felt over a long period after the initial moment of emission into the atmosphere, making it difficult to quickly change the concentration levels in the short term.

There are several different greenhouse gases, each with a different level of global warming impact. Carbon dioxide (CO_2) is the most common anthropogenic greenhouse gas, released into the atmosphere by the combustion of fossil fuels. Secondary to carbon dioxide, the Intergovernmental Panel on Climate Change has listed methane (CH_4), nitrous oxide (N_2O), various hydrofluorocarbons (HFCs) and perfluorinated compounds (e.g. sulphur hexafluoride SF_6) as the main greenhouse gases, in order for increasing potency. While hydrofluorocarbons and perfluorinated compounds are the most potent greenhouse gases, they are released in only very small quantities, together contributing to only 1 percent of the global greenhouse gas emissions. Globally, carbon dioxide, methane and nitrous oxide account for 77 percent, 14 percent and 8 percent respectively. In our analysis we will focus mostly on energy-related CO_2 emissions, which account for 61 percent of all greenhouse gas emissions caused by human activity.

A further rise of the average global temperature on earth is projected to have a multitude of consequences: not only could the rise of the global sea level have a huge impact on coastal areas, but the temperature increase would also change local climate systems and ecologies and affect crop production and agricultural yields. Coral reefs and many species are expected go extinct, being unable to adapt; while changes in ecological systems might actually aggravate climate change due to positive feedback loops such as the release of methane gases caused by the melting of permafrost in tundra regions. A global temperature increase of 4 degrees Celsius is likely to seriously affect global food production, while according to one estimate 200 million people may become permanently displaced due to rising sea levels, heavier floods and more intense droughts by the middle of this century.[4]

[3] IPCC, *Fourth Assessment Report. Climate Change 2007 – Synthesis Report, Summary for Policymakers*, 2007, p. 2. Retrieved at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf on 21 April 2009.

[4] Stern, Lord Nicolas, *Stern Review: The Economics of Climate Change*, 2006, p.vi.

Although there is still quite some uncertainty about the exact effects of a significant rise in global temperature, the crucial consideration is that the costs of the potential impact of climate change are enormous. The Stern Review, issued by the British government, has analysed the economic costs of climate change due to the increase of extreme weather events, impact on the availability of water resources and food production, climate change-induced migration and conflicts. It concluded that the costs associated with climate change under a business-as-usual emissions scenario would far exceed the economic costs of the pre-emptive steps that can be taken toward limiting global temperature increase to 2˚ C, and that therefore early action is strongly recommended. According to the analysis, if no preventive action is taken, climate change could reduce global welfare – measured in terms of global GDP – by 5 to 10 percent, whereas the costs of mitigating emissions are estimated at being 1 percent of annual global GDP by 2050.[5]

Total GHG concentration (CO_2-eq ppm)	**CO_2 concentration** (ppm)	**Global mean temperature increase** (˚C)	**Peaking year for CO_2 emissions**	**Change in CO_2 emissions in 2050** (% of year 2000)
445-490	350-400	2.0-2.4	2000-2015	-85 to -50
490-535	400-440	2.4-2.8	2000-2020	-60 to -30
535-590	440-485	2.8-3.2	2010-2030	-30 to +5
590-710	485-570	3.2-4.0	2020-2060	+10 to +60
710-855	570-660	4.0-4.9	2050-2080	+25 to +85
855-1130	660-790	4.9-6.1	2060-2090	+90 to +140

Table 1.1 Stabilisation scenarios in the U.N. IPCC Fourth Assessment Report. Global mean temperature increase indicates the increase above pre-industrial temperatures. Source: IPCC, *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the IPCC - Summary for Policymakers*, 2007, p. 15 (Table SPM.5).

Stabilisation scenarios

Scenarios about the mitigation of global warming and the necessary stabilisation of greenhouse gas emissions have been based on projections issued by the Intergovernmental Panel on Climate Change, as displayed in Table 1.1.[6] Of these scenarios, two cases in particular have attracted a lot of attention.

The first scenario is aimed at limiting the global temperature increase to 2˚ C. In this most ambitious IPCC scenario, global greenhouse gas concentrations should stabilise in the range of 445 to 490 parts per million of carbon dioxide equivalent (ppm CO_2e). As the concentration of greenhouse gases in the atmosphere has already reached approximately 455 ppm of CO_2e, up from pre-industrial levels of only 280 ppm CO_2e, this

[5] Stern, Lord Nicolas, *Stern Review: The Economics of Climate Change*, 2006, pp. ix, x, xiii.

[6] In the long term, it is estimated that annual global emissions will need to be reduced to below 5 gigatonnes of CO_2-equivalent, which is the level that the earth can absorb without adding to the concentration of greenhouse gases in the atmosphere. This is more than 80 percent below the absolute level of current annual emissions and roughly equivalent to the total Chinese carbon dioxide emissions in 2004. Stern, Lord Nicolas, *Stern Review: The Economics of Climate Change*, 2006, p. xi.

implies that emissions would need to be immediately cut back on a global scale.[7] Energy-related CO_2 emissions would need to peak in 2012 and drop with 13 percent compared to 2005 by 2030. This decrease would have to be accelerated in order to reach reductions of 50 to 85 percent below 2000 levels by 2050.[8] The enormous costs and technological challenges associated with this scenario have made it a rather hypothetical case, and it is already regarded by many as unachievable. For instance, the realisation of this scenario would require the premature retirement of 15% of the world's fossil fuel-fired power generating capacity, and all new generating capacity from 2015 onwards would be required to have zero carbon emissions worldwide.[9]

The second scenario focuses on a greenhouse gas stabilisation level of 550 ppm CO_2e, estimated to be roughly equivalent to a 3˚ C temperature rise.[10] To achieve this stabilisation level, global emissions would need to peak in the next one or two decades and then fall at a rate of at least 1 to 3 percent per year, dropping to around 25 percent below current levels by 2050. Considering that the world economy in 2050 might be 3 to 4 times larger than today, emissions per unit of GDP may need to be just one-quarter of current levels.[11]

While the 550 ppm scenario still has some chance of success, the implications are nothing short of what the International Energy Agency has termed an "energy revolution".[12] Current trends are putting us on track for a temperature increase of 6˚ C by the end of the century. Global greenhouse gas emissions due to human activities increased by 70 percent between 1970 and 2004 and stood at 44 gigatonnes of CO_2-equivalent (Gt CO_2e) in 2005.[13] In a business-as-usual scenario, emissions are projected to increase by another 35 percent by 2030. Within this total, the proportion of energy-related carbon dioxide emissions is expected to grow even faster, rising by 45 percent in the period from 2007 to 2030, showing an average annual growth rate of 1.6 percent.

1.2 The crucial role of China in emissions stabilisation schemes

China surpassed the United States as the world's largest emitter of greenhouse gases in 2007 and will therefore be a vital partner if any stabilisation scheme is to succeed. In fact, due to its rapid growth, its proportion of global greenhouse gas emissions is only set to rise, making China even more crucial.

The rapid growth of emissions coming from China has exceeded the forecasts of many observers. As recently as in its International Energy Outlook 2000, the authoritative U.S. Energy Information Administration projected that China would surpass the United States only around 2020.[14]

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[7] For CO_2 alone, concentration levels have reached approx. 385 ppm. International Energy Agency, *World Energy Outlook 2008*, p.401. Table 1.1 shows how total greenhouse gas vs. CO_2 concentration levels roughly correspond.

[8] Stern, Lord Nicolas, *Stern Review: The Economics of Climate Change*, 2006, pp.iii, xi, xv; International Energy Agency, *World Energy Outlook 2007*, pp. 191, 205, 207-208.

[9] Conform the 450 Stabilisation Case. International Energy Agency, *World Energy Outlook 2007*, pp. 207-214.

[10] International Energy Agency, *World Energy Outlook 2008*, p. 407.

[11] Stern, Lord Nicolas, *Stern Review: The Economics of Climate Change*, 2006, pp.iii, xi.

[12] International Energy Agency, *World Energy Outlook 2008*, p. 37.

[13] In this paper, tonnes will always refer to metric tonnes.

[14] Energy Information Administration, U.S. Department of Energy, *International Energy Outlook 2000*, p. 181.

According to China's own statistics, the total greenhouse gases emitted increased from 4,060 million tonnes of CO_2 equivalent (Mt CO_2e) in 1994 to 6,100 Mt CO_2e in 2004, i.e. a growth of about 50 percent in a period of one decade.[15] Although this would imply an annual average growth rate of greenhouse gas emissions of around 4%, emission growth has accelerated rapidly since 2002, as has China's energy consumption and the consumption of coal in particular. In 2008 national CO_2 emissions growth stood at almost triple the world average for that year, at 8 percent versus 3.1 percent, respectively. China's emissions accounted for about two-thirds of the global carbon dioxide increase compared to 2007. More generally, China is projected to account for 47% of the total global growth in CO_2 emissions between now and 2030.[16]

This enormous growth means that China is rapidly increasing its share of total global emissions. Considering energy-related CO_2 emissions in the period 1973-2006, its global share has already increased from 5.7 percent to 20.2 percent and is forecasted to increase to nearly 30 percent by 2030.[17]

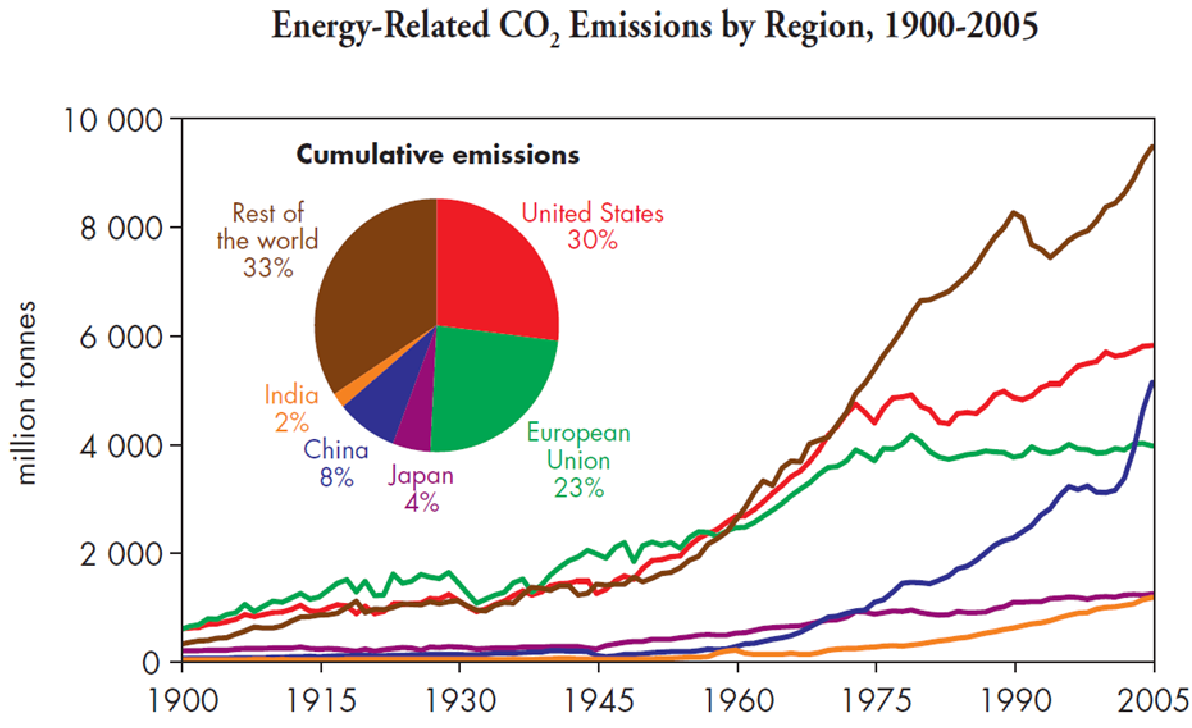

Figure 1.1 Energy-Related CO_2 emissions and cumulative emissions by region, 1900-2005. Source: International Energy Agency, *World Energy Outlook 2007*, p. 201.

[15] National Development and Reform Commission, *China's National Climate Change Programme*, June 2007, p. 6.

[16] Netherlands Environmental Assessment Agency, 'China contributing two thirds to increase in CO_2 emissions', 13 June 2008. Retrieved at http://www.mnp.nl/en/service/pressreleases/2008/20080613ChinacontributingtwothirdstoincreaseinCO2emissions.html on 15 Jan 2008; Energy Information Administration, U.S. Department of Energy, *Emissions of Greenhouse Gases Report*, 3 December 2008. Retrieved at http://www.eia.doe.gov/oiaf/1605/ggrpt/ on 2 Feb 2009.

[17] International Energy Agency, *Key World Energy Statistics 2008*, p. 30. Forecast is the Reference Scenario for 2030 from the International Energy Agency, *World Energy Outlook 2008*.

Between 1900 and 2005 China contributed only 8 percent of worldwide cumulative energy-related CO_2 emissions. However, as is clear from the above-mentioned growth perspectives, this will change substantially in the coming decades. By 2030 China's cumulative emissions since 1900 are expected to have almost surpassed those of Europe, but the U.S. will still be ahead by about 25 percent compared to China.[18] Figure 1.1 shows the development of energy-related CO_2 emissions over the past century, illustrating the rapidly growing importance of China vis-à-vis global emissions.

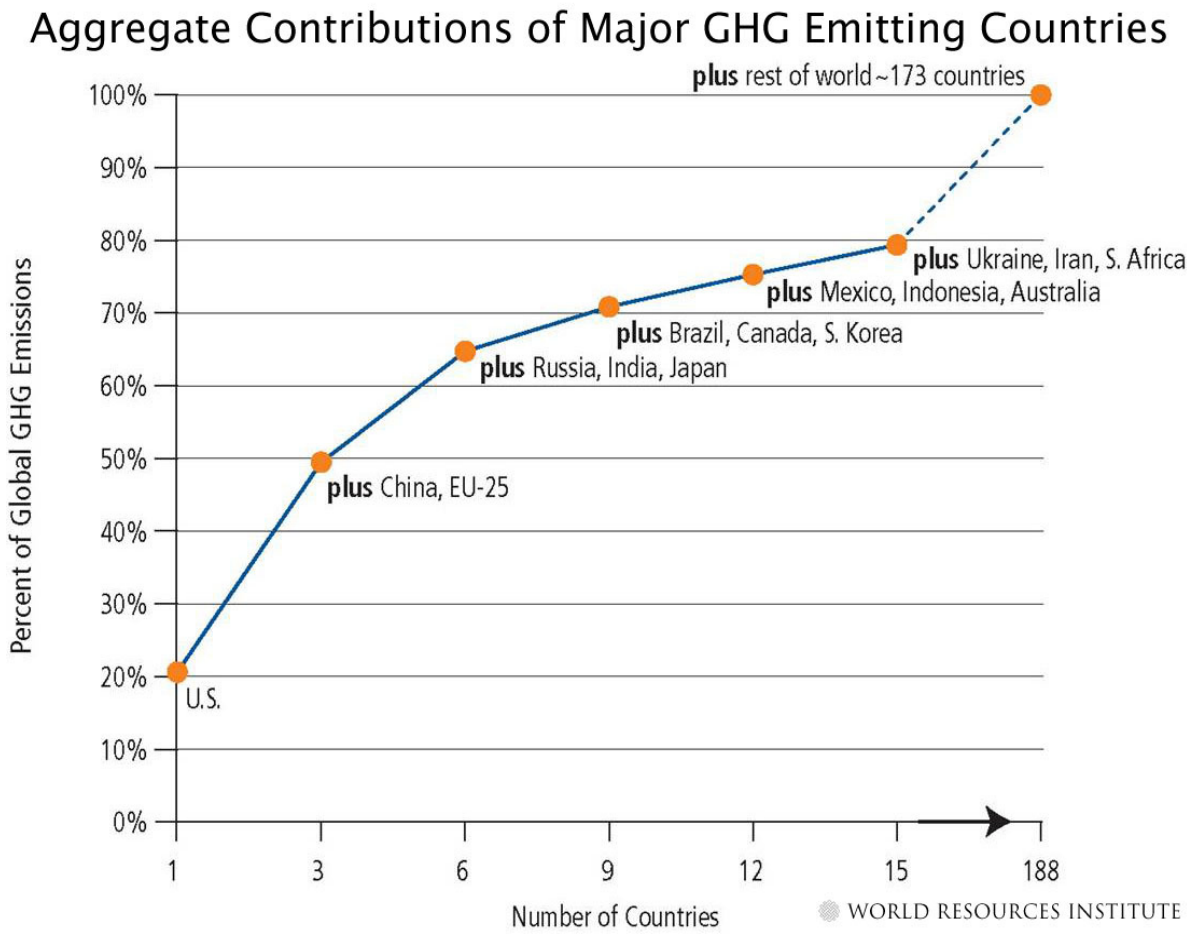

Figure 1.2 Aggregate Contributions of Major GHG Emitting Countries.
Source: World Resources Institute, updated with 2005 data.

Future estimates of Chinese emissions compared with stabilisation schemes

For there to be any stabilisation of global greenhouse gas emissions, the participation of the largest emitters will be essential. Figure 1.2 illustrates the most important countries involved, the top five and their share in global emissions being: China (20%), U.S. (20%), E.U. (14%), Russia (5.6%), India (4.5%) and Japan (4.3%).[19]

[18] International Energy Agency, *World Energy Outlook 2007*, p. 201. Forecast is the Reference Scenario for 2030.

[19] Percentages based on 2006 energy-related CO_2 emission data from the IEA, hence a slight discrepancy with Fig. 1.2.

Following current trends, China's energy-related CO_2 emissions are projected to reach 11.7 Gt by 2030, which by that time will constitute 29 percent of global emissions under a business-as-usual scenario.[20] This presumes that Chinese emissions will grow at an annual rate of 3.1 percent from now until 2030 – almost double the global average annual emissions growth, projected to be 1.6 percent.

Accommodating this unfettered growth would pose a nearly insurmountable challenge for the stabilisation schemes introduced in the previous section. In the 450 and 550 ppm stabilisation scenarios, global energy-related emissions would need to peak in 2012 and 2025 respectively, which would be nearly impossible if emissions from China continue to grow at a rapid pace, pointing out the urgency of including China in mitigation efforts.

According to the International Energy Agency, to have any chance of achieving either the 450 ppm or the 550 ppm scenario, global energy-related CO_2 emissions would need to be reduced by approximately 10 percent by 2020 compared to their business-as-usual Reference Scenario.[21] Burden sharing and how to allow for developing countries to increase emissions in the short term without endangering stabilisation objectives are crucial issues in this matter. For example, if a commitment to reduce emissions were to be undertaken by the OECD, China, India, Russia and the Middle East (excluding other countries from a commitment to improve upon their business-as-usual trajectory), this would entail an average reduction target of 12 percent per region. If the OECD would take on the burden of reducing emissions alone it would need to achieve a reduction of 27 percent by 2020 compared to 2006 emissions levels.[22]

For the success of longer term mitigation scenarios, focused on 2030, the participation of non-OECD countries becomes essential. The 450 ppm stabilisation scenario cannot be achieved without the involvement of non-OECD countries such as China, as the required reduction of annual global CO_2 emissions exceeds the amount projected to be emitted by the OECD in 2030. Hence, even if the OECD countries would reduce their emissions to zero by 2030, the 450 ppm trajectory would not be met.[23]

In the 550 ppm stabilisation scenario, energy-related CO_2 emissions would need to peak in 2025 and then decline slightly to 33 Gt in 2030. For this scenario, the necessary global reduction in energy-related CO_2 emissions is equivalent to 58 percent of the projected OECD emissions in 2030. To make such drastic cuts in emissions in a period of just two decades is considered to be unrealistic by many observers, pointing out the need for China to be included in the global effort to limit emissions.

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[20] According to the Reference Scenario. International Energy Agency, *World Energy Outlook 2008*, pp. 507,531.

[21] This would still allow for a growth in absolute global emissions between 2006 and 2020 of about 4.6 Gt of CO_2. However, China's projected business-as-usual growth in emissions over this period (4.4 Gt) would already nearly occupy all of this.

[22] This would denote a reduction of about 15% compared to OECD energy-related CO_2 emissions levels in 1990. This requirement is still relatively mild compared to the reductions in total greenhouse gas emissions called for by the *Ad Hoc Working Group* of the UNFCCC working on the Kyoto-track, which has called upon developed countries to make reductions of 25 to 40 percent compared to 1990 levels by 2020. Yet one should take care of comparing these targets as one refers to energy-related CO_2 emissions while the other refers to total greenhouse gases emissions. UNFCCC, *Report of the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol* [held in Bali at COP-13 from 3 to 15 December 2007] (FCCC/KP/AWG/2007/5), 5 February 2008. Retrieved at http://unfccc.int/resource/docs/2007/awg4/eng/05.pdf on 10 June 2009.

[23] International Energy Agency, *World Energy Outlook 2008*, pp. 416-418.

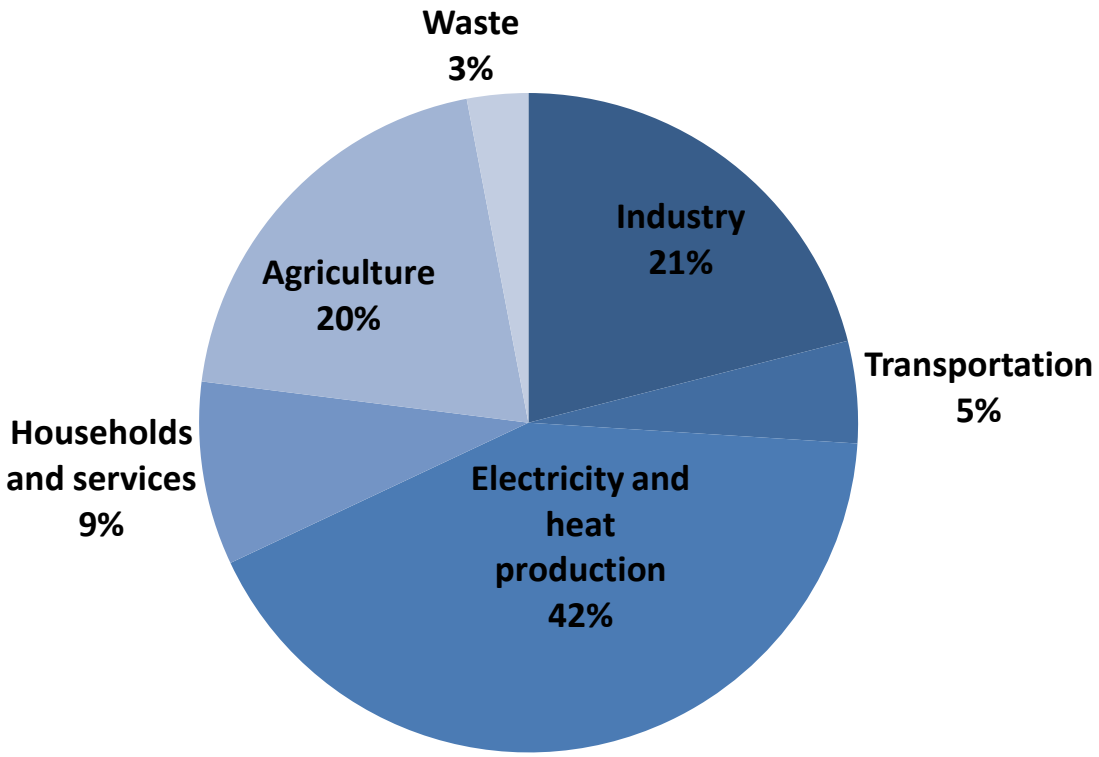

Figure 1.3 Chinese greenhouse gas emissions by sector in 2003.
Source: Congressional Research Service, Report for Congress, *China's Greenhouse Gas Emissions and Mitigation Policies*, 10 September 2008.

In order to assess the potential of emissions mitigation efforts in China, we will study more closely the drivers behind China's greenhouse gas emissions.

1.3 An analysis of China's greenhouse gas emissions

China's greenhouse gas emissions are inexorably tied to its huge coal consumption. Coal combustion accounts for about 75 percent of China's overall carbon dioxide emissions, which in turn account for about four-fifth of China's total greenhouse gas emissions. Methane and nitrous oxide emissions, which are mainly caused by agriculture and changes in land use, contribute only 12 percent and 5 percent respectively, setting China apart from more agriculturally-oriented developing countries.

The fact that coal combustion is the major source of Chinese carbon dioxide emissions is quite unsurprising given that China's energy system is dominated by coal, which fuels 70 percent of China's primary energy consumption. As industry and the power generation sector each account for about half of China's coal consumption, it also comes as no surprise that these are the major sources of CO_2 emissions, respectively accounting for

42 percent and 21 percent of Chinese total greenhouse gas emissions (see Figure 1.3). In addition, the industrial sector is also by far the largest consumer of electricity, consuming 68 percent of all generated power, indirectly contributing even more to the total emissions.[24]

As of yet, transportation and the residential and commercial sectors have not been major contributors to Chinese greenhouse gas emissions: their share of total emissions stands at 5 and 9 percent, respectively (see Figure 1.3). This can be interpreted as an indication of China's level of development, as these shares will certainly increase with continuing economic development. In comparison: in the United States emissions from industry account for 27 percent of the total, transport for 34 percent and residential/commercial energy use for 39 percent.[25]

The discrepancy in these percentages is an alarming sign of the potential growth of emissions that we can expect. In the words of one analyst: "[China's] current GHG emissions pale in comparison to what can be expected in the coming decades."[26]

1.4 China's massive potential for climate change mitigation

China is not only important because of its large and increasing share of carbon emissions. Its involvement in a global climate change mitigation scheme is also essential because the country contains some of the biggest potential areas for long-term emissions mitigation, as it is still in the process of laying out the infrastructure which will determine its energy consumption and carbon emissions levels for years to come.

Three areas are considered to be of prime importance:

Power sector

The power sector in China is expanding at a tremendous pace, having accelerated since 2002 to annual growth rates of 12-16 percent. This crucial sector accounts for half of all coal consumed in China, and almost half of all CO_2 emitted. Moreover, it is projected to account for more than 85 percent of the incremental coal consumption growth up to 2030, with dramatic consequences for China's emissions levels.[27]

Unfortunately, the much-quoted figure of three to four 500 MW coal-fired power plants coming online in China every week has been more or less true for the past three years.[28] While the current growth is mainly driven by energy-intensive industrial manufacturing, a huge potential increase in residential and commercial electricity use guarantees that power generation growth will continue at a rapid speed. In the past few years, 90-100 GW of capacity has been added each year, roughly corresponding to the size of the

[24] Asia Pacific Energy Research Centre (APERC), *APEC Energy Overview 2007*, January 2008, p. 46.

[25] Energy Information Administration, U.S. Department of Energy, *Flowchart of GHG emissions USA 2007*, 3 December 2008. Retrieved at http://www.eia.doe.gov/oiaf/1605/ggrpt/flowchart.html on 10 January 2009.

[26] Tu, Jianjun, 'Future Prospects of China's Policy on Climate Change', *China Brief* IX, no. 1 (2009).

[27] Asia Pacific Energy Research Centre, *Understanding Energy in China*, 2008, p. 59.

[28] Steinfeld, Lester, Cunningham, *Greener Plants, Greyer Skies? A Report From the Frontlines of China's Energy Sector*, China Energy Group, MIT Industrial Performance Center, August 2008, p. 2.

complete power sector of the United Kingdom.[29] With this breakneck speed expansion, China is laying the foundation of its power sector for the decades to come. The implications of the manner in which this foundation is being laid, from an environmental and climate perspective, cannot be overstated.

Considering that most modern power plants have a lifespan of at least four decades and, knowing that one 500 megawatt coal-fired power plant produces approximately 3 million tonnes of carbon dioxide per year,[30] the three to four coal-fired power plants being added each week in China amount to an increase in annual CO_2 emissions of 9 to 12 million tonnes – emissions which will be sustained over the greater part of this century, if one acknowledges that installing and retrofitting carbon capture and storage technology in China on a large-scale will be an extremely difficult task; and considering that it will be highly expensive to remove these power plants from operation before they have completed their technical lifespan.[31]

In fact, the capacity which has already been built is determining to a large degree our future global emissions level. The International Energy Agency has projected that three-quarters of the output of electricity generated in 2020 worldwide – and more than half in 2030 – will come from power stations that are in operation today.[32] This indicates the limited amount of leverage that we have by changing the expansion plans of our current power sector. As the Agency remarks, even if all power plants built from now on are carbon-free, CO_2 emissions from the power sector would still be only 4 billion tonnes (25%) lower in 2020 relative to its Reference Scenario.

Turning the perspective around, the enormous expansion of power generation capacity in China offers a unique chance to make a real difference in future emissions levels. If it can be directed to a more sustainable and low-carbon pathway, it *will* have a huge impact. However, the expansion is taking place at this moment, and if we want to make use of this chance, we should do it now. In a few decades this chance will have passed.[33]

Housing

A similar argument holds for the housing boom in China. Urbanisation is already an important driver of increasing carbon emissions, due to rapid housing and infrastructure construction, higher residential energy consumption and surging electricity demand. In the period from 2000-2006, China's urban population expanded

[29] Recent capacity figures: 517 GW (2005), 623 GW (2006), 713 GW (2007), ca. 800 GW (2008).

Data: *China Electric Power Statistical Yearbook*, 2007; *Caijing Magazine*, 'China to Invest More in the Power Grid', 6 January 2009. Retrieved at http://english.caijing.com.cn/2009-01-06/110045381.html on 12 February 2009.

[30] Massachusetts Institute of Technology, *The Future of Coal*, 2007, p. ix.

[31] Inter Academy Council, *Lighting the way: Towards a Sustainable Energy Future*, 2007, pp. 61-74,150-151.

[32] IEA, *World Energy Outlook 2008*, Executive Summary, p. 12.

[33] According to a McKinsey report issued in February 2009, a 5-year delay in starting to implement abatement technologies would result in a loss of one-third of the total abatement potential projected for 2030. Waiting 10 years before starting implementation, up to 60 percent of the potential could be lost. McKinsey&Company, China's *Green Revolution*, 2009, p. 13. McKinsey Global Institute, *Fueling sustainable development: The energy productivity solution*, October 2008, pp. 4-5; International Energy Agency, *World Energy Outlook, 2007*, p. 51.

by 26 percent from 459 to 577 million residents. Every year, about 15 to 20 million rural residents move to the cities.[34]

In order to accommodate these migrants, China is engaged in a veritable construction frenzy. It is estimated that about half of all housing being built worldwide is constructed in China, where an urban area comparable to two times Boston, Massachusetts, is added each month.[35] The resources needed to construct 2 billion square meters of floor space per year have led to an enormous rise in the production of steel, cement and glass. Cement production, for instance, which accounts for 9.8 percent of China's industrial CO_2 emissions, has more than doubled from 597 million tonnes in 2000 to 1.24 billion tonnes in 2006. As a result, China currently produces almost half of the world's total amount of cement.[36]

Yet the crucial aspect of this construction boom is not so much the energy intensity of the construction itself. Rather, it is the quality of the housing that is constructed which will determine future energy consumption and emissions to a large degree, as technology becomes locked-in. In developed countries, buildings account for 30 to 40 percent of the total energy consumption via heating, cooling, lighting and other appliances. This represents a field with a huge potential for emissions reduction in China, as current building practices are on average still far behind international standards.[37] As an indication, Chinese residential buildings are reported to consume twice as much energy for heating as those in developed countries.[38] The measure of energy efficiency and insulation of buildings being constructed in China will be critical in limiting their future energy consumption. Again, the rapid expansion offers a great mitigation opportunity, as retrofitting buildings is far more costly than building them to be energy efficient in the first place. Again, this is a chance that needs to be seized now.

Transportation

The most recent key area is transportation. Although the automobile has had very limited market penetration up to now, thus playing a minimal role in China's overall emissions, skyrocketing sales volumes ensure that transportation-related emissions will grow tremendously in importance. In China, only 24 persons out of every one thousand currently own a car, a figure that is expected to rise to 40 per thousand by 2010. In comparison, this figure now stands at approximately 1 out of 2 persons in Europe and more than 700 per thousand in the United States.[39] In early 2009 China overtook the United States as the biggest market for cars in terms of sales volume.

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[34] Levine, Mark D. and Aden, Nathaniel T., *Global Carbon Emissions in the Coming Decades: The Case of China*, 2008, pp. 20-22; Stern, Todd, Remarks at the Center for American Progress, 3 June 2009.

[35] Stern, Todd, Remarks at the Center for American Progress, 3 June 2009.

[36] Levine, Mark D. and Aden, Nathaniel T., *Global Carbon Emissions in the Coming Decades: The Case of China*, 2008, pp. 20-21; Carbon Dioxide Information Analysis Center (CDIAC), *People's Republic of China Fossil-Fuel CO_2 Emissions*, 2009. Retrieved at http://cdiac.ornl.gov/trends/emis/tre_prc.html on 15 May 2009.

[37] International Energy Agency, *Buildings and Community Systems (ECBCS)*. Retrieved at http://www.iea.org/textbase/techno/iaresults.asp?id_ia=12 on 12 May 2009; United Nations Environment Programme (UNEP), *Buildings*, Part II Section 2 in: *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World,* September 2008, p. 131.

[38] Levine, Mark D. and Aden, N. T., *Global Carbon Emissions in the Coming Decades: The Case of China*, 2008, pp. 20-21.

[39] *Xinhua News*, 'Every 1000 Chinese to own 40 cars in 2010', 24 May 2006. Retrieved at http://news.xinhuanet.com/english/2006-05/24/content_4594750.htm on 5 April 2009; UNECE Transport Division, *The Statistical Yearbook of the Economic Commission for Europe 2005*. Retrieved at

On a global level, emissions from transportation amount to almost one-quarter of the total energy-related CO_2 emissions – a huge share compared to the 6 percent in China.[40] Limiting future emissions from transport is one of the toughest challenges in climate change mitigation, and rising transportation emissions are projected to contribute one-fifth of the increase in global emissions between now and 2030.[41] Improving the fuel efficiency standards of petroleum-fuelled vehicles, the deployment of hybrid and electric cars and the development of alternative modes of transport can all have a significant impact on China's future emissions.

1.5 The Chinese energy system and energy policy

The structure of China's CO_2 emissions mirrors its energy system, both being dominated by coal. This dominance can be explained by the fact that China has large coal reserves, which are especially significant given its limited reserves of other fossil fuels. In this section we will briefly analyse China's energy system, after which we will discuss its overall energy policy and energy security strategy.

Structure of China's energy consumption

Contrasted with its enormous size and population, China has rather limited reserves of fossil energy resources. Proven oil and gas reserves respectively account for just 1.2 and 1.3 percent of the world's total reserves, and the only fossil fuel which is available in large quantities is coal. China has proven recoverable reserves of 114.5 billion metric tonnes of coal, equivalent to a share of 13.9 percent of the world's total. This puts China in third place behind the U.S. (28.9%) and the Russian Federation (19.0%).[42]

During the initial stages of China's industrial development, coal quickly became the main feedstock. Apart from being the most abundant and easily accessible source of energy, coal also required less investment in order to produce it as compared to oil and gas, adding to its advantage. Consequently, coal has taken up a dominant share in China's fuel mix, accounting for about 70 percent of China's total energy consumption in recent years (see Figure 1.4). Although this percentage stood at a higher level of around 75 percent in the early 1990s, policies aimed at reducing the share of coal in China's fuel mix have not been fully successful. In 2002 the share of coal fell to a low of 66.3 percent, but it has been steadily increasing since then. The demand for coal is almost completely concentrated in two sectors: power generation and industry.[43] Four-fifths of all electricity in China is generated using coal-fired power plants, and coal is the main fuel of China's heavy industries producing iron, steel, cement, building materials and nonferrous metals.

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http://www.unece.org/stats/trends2005/Sources/145_Number%20of%20passenger%20cars%20(per%201000%20pop).pdf on 25 May 2009.

[40] International Energy Agency, *World Energy Outlook 2008*, pp. 507, 531.

[41] International Energy Agency, *World Energy Outlook 2008*, p. 392.

[42] British Petrol, *Statistical Review of World Energy*, June 2009, p. 32.

[43] Power generation and industry account for respectively 50 percent and 43 percent of China's total domestic coal demand (data over 2006). APERC, *Understanding Energy in China*, 2008, p. 45.

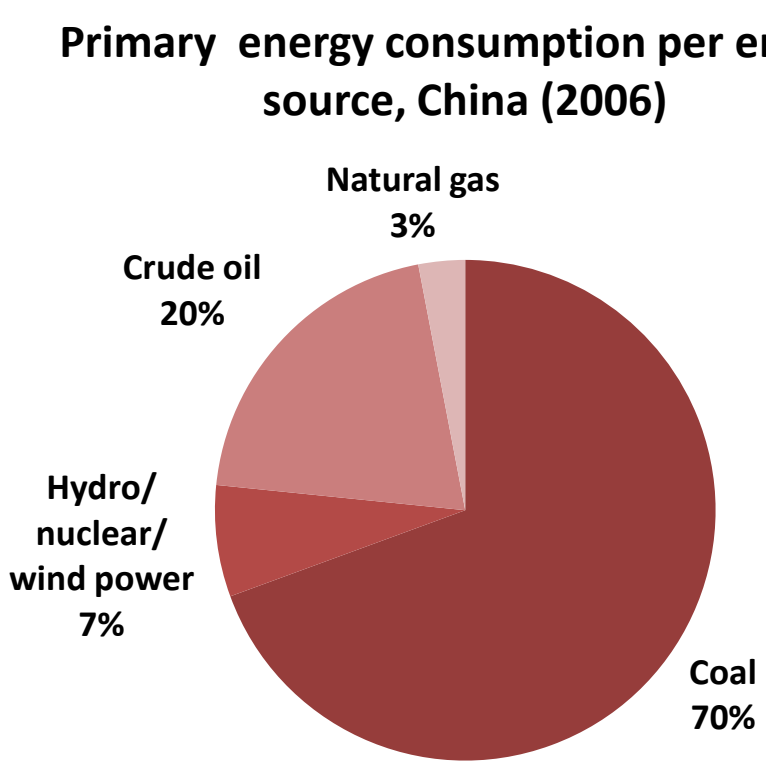

Figure 1.4 Primary energy consumption by energy source, China (2006).
Source: *China Statistical Yearbook 2008*.

Despite limited oil reserves China has developed a large domestic petroleum industry and currently produces 3.8 million barrels of crude oil per day, making it the world's fifth largest producer. Nonetheless, its oil consumption, driven mainly by transportation fuel demand, has outpaced domestic production, leaving China dependent on imports for more than half of its current consumption. With imports amounting to 4.4 million barrels per day, it is the world's third largest oil importer after the U.S. and Japan, making China an increasingly influential actor in international oil markets.[44]

Gas is still relatively underdeveloped in China and takes up a share of 3% in the current fuel mix. However, the consumption of natural gas is growing quickly, and China is expected to soon become a major gas importer as well. China started importing liquefied natural gas (LNG) in 2006, and construction has commenced on a pipeline bringing gas from Turkmenistan to China's western border.[45]

China's overall energy policy

A renewed coherent formulation of China's energy security and energy development strategy has been suggested by the State Council's Development Research Centre in its

[44] Data are annual figures over 2008, taken from: British Petrol, *Statistical Review of World Energy*, June 2009. Of China's 4.4 million barrels per day of oil imports, 3.6 million barrels are crude oil, 0.8 million barrels are oil products.

[45] National Bureau of Statistics, *China Statistical Yearbook 2008*; Energy Information Administration, U.S. Department of Energy, *International Energy Outlook 2009*, p. 44; *World Gas Intelligence*, 'China's Turkmen Pipe', Vol. XIX, No. 10, March 5, 2008.

National Energy Policy and Strategy report in 2004.[46] Key elements of this report have found their way into subsequent government targets and policies, most notably in the white paper on energy entitled *China's Energy Conditions and Policies*, released at the end of 2007 by the State Council. Based on these documents, one can infer the most important objectives of China's general energy policy:[47]

1. Focus on energy conservation to ensure sustainability and greatly increase energy efficiency in order to achieve a quadrupling of GDP by 2020 as compared to 2000 while only doubling energy consumption. For the period 2005-2010 this translates into an energy intensity reduction target of 20 percent.

2. Decrease the reliance on coal in total energy consumption. Promote clean coal technologies in industry and power generation sectors and introduce coal liquefaction to produce transport fuels.[48]

3. Ensure sufficient supplies of oil by maximizing domestic production and supporting overseas investments.

4. Rapidly expand domestic production and use of natural gas, with the goal of increasing the share of natural gas in China's fuel mix to 10 percent by 2020.[49]

5. Continue the substantial expansion of hydropower to maintain (or increase) the share of hydro-generated electricity. China aims to have 300 GW of installed hydropower capacity in 2020.[50]

6. Pursue a rapid development of nuclear power, increasing capacity to 40 GW in 2020. This would increase the share of nuclear-generated electricity to 4 percent (up from 1 percent in 2005).[51]

7. Vigorously develop renewable energy sources including biomass, wind, solar, geothermal and tidal energy. Increase renewable energy consumption to 10 percent of the total energy consumption by 2010 and 15 percent by 2020.

The elements of this energy development strategy will be analysed in following sections, with a particular focus on their impact on greenhouse gas emissions. We will return to the issue of China's policy on coal – the main cause of its emissions – in section 4.2. An

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[46] An excellent review of this strategic document is given by: Sinton, J.E., Stern, R.E., Aden, N.T. and Levine, M.D., 'Evaluation of China's Energy Strategy Options', Lawrence Berkeley National Laboratory, May 2005.

[47] Sinton, J.E., Stern, R.E., Aden, N.T. and Levine, M.D., 'Evaluation of China's Strategy Options', Lawrence Berkeley National Laboratory, May 2005, pp. 10-19; Fridley, D. 'Natural Gas in China', Chapter 2 in: Stern, J., *Natural Gas in Asia*, Oxford University Press, 2008, pp. 42-43.

[48] The suggested (unofficial) goal by the National Energy Policy and Strategy report is a share of 60 percent by 2020; see: Sinton, J.E., Stern, R.E., Aden, N.T. and Levine, M.D., 'Evaluation of China's Strategy Options', Lawrence Berkeley National Laboratory, May 2005, p. 14. According to the most recent China Statistical Yearbook (2008) the share of coal in China's total energy consumption stood at 69.4 percent. Data over 2006.

[49] The 10 percent target is put forward in the 10th Five-Year Plan (2001-2005). Fridley, D. 'Natural Gas in China', Chapter 2 in: Stern, J., *Natural Gas in Asia*, Oxford University Press, 2008, p. 42.

[50] Hydropower capacity stood at 172 GW at the end of 2008.

[51] Current nuclear power generating capacity stands at 8.6 GW. This target is currently under revision, see section 2.4.

overall discussion of Chinese energy policymaking is also included in Chapter 4. Policies stimulating energy efficiency, the development of renewable energy sources and nuclear power will be addressed in Chapter 2.

Energy security concerns

Despite all efforts toward maintaining its self-sufficiency, China became an oil importer in 1993. China now imports 4.4 million barrels per day, slightly more than half of its total consumption, but import dependency might rise to 80 percent by 2020.[52] In response to this energy security threat, Chinese oil majors have become quite active players on the world oil market, often acting in tandem with the Chinese government in order to secure deals on the exploitation of overseas oil resources. Especially due to the controversial involvement of Chinese oil companies in Sudan, Iran and several other countries, this policy has attracted a lot of criticism.[53] Nonetheless, the strategy has not been unsuccessful for China, which has achieved a rather diversified set of oil suppliers.[54] Yet future growth of oil consumption will pose a major problem for China, as global production capacity is becoming increasingly constrained.[55] Although global oil demand has receded as a consequence of the global economic crisis, the simultaneous drop in investment in the energy sector is expected to aggravate the supply problem, raising expectations of future price spikes and market volatility.[56]

Natural gas occupies only a minor place in China's energy system, but consumption is growing quickly and demand could reach 200 billion cubic metres by 2020. This projected level of consumption will require significant imports, despite the fast growth rates of domestic production. China has been investing heavily in LNG terminals, allowing for gas imports at its most populous coastal regions. Projects for pipeline connections to Turkmenistan (via Uzbekistan and Kazakhstan) and Russia are also in progress, enhancing China's import options. Overall, the government hopes to maintain China's gas import dependency below 50 percent by 2020.[57]

Third, even the security of supply concerning coal is limited. In the short to medium term, the problem lies in constraints of domestic production capacity and transportation infrastructure, both of which have already been placed under a heavy strain due to enormous growth in recent years. On a per capita basis, China's coal reserves are lower than the world average, and the current reserve/production ratio shows that they will

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[52] Fridley, D., 'Natural Gas in China', Ch. 2 in: Stern, J., *Natural Gas in Asia*, Oxford University Press: 2008, p. 60. This estimate envisions a very high demand growth. Other estimates are a bit more conservative. The IEA, *WEO2008* Reference Scenario projects an oil import dependency of 75% in 2030 (p. 105).

[53] International Crisis Group, *China's Thirst for Oil*, Crisis Group Asia Report no. 153, June 2008.

[54] See: International Energy Agency, *World Energy Outlook 2007*, Figure 10.5, p. 325.

[55] Jesse, Jan Hein and van der Linde, Coby, *Oil Turbulence in the next decade: an essay on high oil prices in a supply constrained world*, The Hague: Clingendael International Energy Programme, 2008. Ten Kate, Warner and van Geuns, Lucia, 'Turmoil on the International Oil Markets: Getting Used to Production Capacity Constraints', in *Challenges in a Changing World. Clingendael Views on Global and Regional Issues*, de Zwaan, Jaap; Bakker, Edwin, and van der Meer, S., (eds.),The Hague: TMC Asser Press, 2009.

[56] International Energy Agency, *The Impact of the Financial and Economic Crisis on Energy Investment*, 2009.

[57] Most current forecasts centre around a consumption level of 200 bcm by 2020, with production probably reaching a maximum of 120 bcm. Fridley, D., 'Natural Gas in China', Ch. 2 in: Stern, J., *Natural Gas in Asia*, Oxford University Press: 2008, pp. 43, 60. The forecast by the Energy Information Agency in its *International Energy Outlook 2009* is much more conservative however. Their reference case projects China's gas import dependency at 37 percent in 2030. Energy Information Administration, U.S. Department of Energy, *International Energy Outlook 2009*, pp. 39, 44, 127.

last for another 41 years. However, with consumption rising so explosively, supply problems can be expected to appear as soon as the coming decades, possibly leading to coal import levels of 10 to 20 percent by 2020.[58]

[58] BP, *Statistical Review of World Energy*, June 2009, p. 32; McKinsey & Company, *China's Green Revolution*, 2009, p. 9.

2

Positive trends in China for climate change mitigation

Considering its reputation for being the world's largest polluter, China seems an unlikely initiator of strong action on climate change mitigation. Not unlike many other developing countries, economic development in China has often been achieved at the cost of environmental degradation. The overriding priority given to economic growth has led to increased desertification, soil erosion, water shortages, dispersal of toxic waste, declining quality of drinking water and air pollution, to name but a few of the more conspicuous consequences.[59] Its poor record on environmental protection has been criticised widely, and the lack of action in this field does not bode well for effectively addressing the challenge of global warming. This is particularly worrying because the root causes that lie at the heart of many of its environmental problems are the same that induce its rising greenhouse gas emissions: the predominance of energy-intensive industry in the Chinese economy combined with its coal-based energy system.

Yet China's energy and climate change policy has received unexpected praise by the United States administration. In his address to the Congress, shortly after taking office, President Obama hailed China as having the launched "the largest effort in history to make their economy energy-efficient".[60] Todd Stern, the lead negotiator on climate change for the United States, has remarked that "[t]he Chinese are doing a lot already".[61] The praise forms the recognition of the fact that even while China has been slow in paying more attention to environmental and climate concerns, a shift in awareness at government level can be said to have taken place. After the entry into force of the Kyoto Protocol in 2005, China has been quick to step up its efforts related to climate change. It has issued a *National Climate Change Programme* in June 2007, followed by a government white paper on climate change one year later. The climate change mitigation actions that are presented are mostly a reshuffling of earlier policy on energy and environment, often instigated out of concerns of energy security, sustainability and air pollution, or motivated by economic gains. Nonetheless, the programme presents an ambitious effort which has a significant impact on China's developmental trajectory. This chapter will discuss several positive trends in the current domestic action undertaken by China concerning energy and climate change.

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[59] In fact, this disregard for the environmental repercussions of economic growth is a quite common trait of countries in the midst of rapid economic development: similar patterns characterised the development of China's East-Asian neighbours Japan and South Korea in earlier stages. See for instance: Emmott, Bill, 'What China can learn from Japan on cleaning up the environment', *McKinsey Quarterly*, no.4, 2008.

[60] President Obama's address to joint session of Congress, 24 February, 2009. Retrieved at http://www.whitehouse.gov/the_press_office/Remarks-of-President-Barack-Obama-Address-to-Joint-Session-of-Congress/ on 30 March 2009.

[61] Reuters, 'U.S. praises China's climate efforts; urges more', 29 March 2009. Retrieved at http://www.reuters.com/article/latestCrisis/idUSLT67579 on 30 March 2009.

Box 2

China's key officials on climate change

Mr. **Wen Jiabao**	Premier and Chairman of the National Leading Group on Climate Change
Mr. **Xie Zhenhua**	Vice-minister of the National Development and Reform Commission, Head of the National Climate Change Coordination Committee
Mr. **Yu Qingtai**	Special Representative for Climate Change Negotiations, Ministry of Foreign Affairs
Mr. **Su Wei**	Director General of the Office of the National Leading Group on Climate Change / Department of Climate Change, National Development and Reform Commission

The embedding of the Department of Climate Change inside the National Development and Reform Commission means that the NDRC heads the delegation to the climate negotiations (often at the vice-ministerial level), while the Ministry of Foreign Affairs usually supplies the lead negotiator. At the moment the Deputy Director of the NDRC, Xie Zhenhua, is also heading the Climate Change Coordination Committee. As lead negotiator and Special Representative for Climate Change Negotiations, the Ministry of Foreign Affairs has appointed the diplomat Yu Qingtai, previously the ambassador of the People's Republic of China in Tanzania. Together with Mr. Su Wei, Director General of the Office of National Leading Group on Climate Change, they form the top Chinese officials involved with climate change and the international negotiations.

2.1 Climate change on the political agenda

As a political topic, climate change has steadily moved up the ranks inside Chinese bureaucracy in the past decade. Initially, research and coordination on climate change was the domain of the scientific China Meteorological Administration, which also represented China in the Intergovernmental Panel on Climate Change (IPCC).[62] As a step towards more centralised policymaking on climate change, a National Climate Change Coordination Committee was created in 1990.[63] This inter-ministerial committee consisted of fifteen members and was chaired by the National Development and Reform Commission (NDRC).[64] The influence of the NDRC was further increased with the establishment of a Department of Climate Change in 1998, which functions as a secretariat to the coordination group. As the NDRC is responsible for China's macro-

[62] Qin Dahe, administrator (and later director) of the China Meteorological Administration has been co-chair of the IPCC Working Group I.

[63] The name of this committee can also be translated as the National Climate Change Leading Small Group. The Chinese name is 国家气候变化对策协调领导小组.

[64] This was later extended to comprise 17 ministries and agencies. National Development and Reform Commission (NDRC), *China's National Climate Change Programme*, June 2007, p. 12.

economic policy, the integration of the political management of climate change within the commission indicates that the issue is increasingly viewed as a political and economic issue. The culmination of the rise of climate change up the ranks of the governmental system came in June 2007 when, together with the publication of *China's National Climate Change Programme*, an additional *National Leading Group on Climate Change* was set up, chaired by Premier Wen Jiabao.[65]

Chinese policy addressing climate change

After the Kyoto Protocol came into force in 2005, attention for climate change was stepped up, and in June 2007 the State Council launched *China's National Climate Change Programme*, outlining a whole range of domestic policy measures taken to address climate change in China. This programme has been followed up by a government white paper: *China's Policies and Actions on Climate Change*, issued in October 2008. The content of the two documents will be briefly summarised.

Achievements are heralded, such as the drop in energy intensity by 49.5 percent in 2005 as compared to 1990 levels, corresponding to an annual decrease of 4.1 percent. The proportion of coal in China's primary energy mix was brought down from 76.2 percent in 1990 to 68.9 percent in 2005. Regarding carbon sinks for offsetting emissions, an aggressive afforestation policy increased forest cover from 8.6 percent in 1951 to 18.21 percent in 2005.[66]

Based on the average CO_2 intensity levels of China in 1994, the *National Climate Change Programme* calculates the quantity of emissions that has been avoided as a result of measures already taken. Compared to the estimated emissions of 6.1 billion tonnes of CO_2e in 2004, China claims to have saved 1.8 billion tonnes due to 300 million births

Box 3

China's National Climate Change Programme – ***Targets for 2010***

Energy related

1) Reduction of 20% in energy intensity (i.e., energy consumption per unit of gross domestic product).
2) Raise proportion of renewable energy, including large-scale hydro, in primary energy supply up to 10%. This stood at 7.5% in 2005.
3) Implement energy conservation programmes, projected to conserve an additional 550 Mt of CO_2 emissions in the period 2005-2010, i.e., 110 Mt of CO_2 annually.

Non-energy related

4) Increase forest cover to 20%. This stood at 18.2% in 2005.
5) Decrease emissions of SO_2 and discharge of chemical oxygen (COD) with 10% by 2010.

[65] The Chinese equivalent names are 国家气候变化领导小组 (National Leading Group on Climate Change) and 国家气候变化对策协调小组 (National Climate Change Coordination Committee).

[66] National Development and Reform Commission, *China's National Climate Change Programme* [中国应对气候变化国家方案], June 2007.

which have been avoided owing to its one-child policy. Investment in renewable energy, including large hydropower projects, has saved another 380 million tonnes of CO_2e emissions.

Emissions avoided by 2010 (Mt of CO_2e)	Measure
550	Implement various energy conservation programmes
500	Continue to expand hydropower for electricity generation
200	Develop coal-bed methane (CBM) and coal-mine methane (CMM)
110	Upgrade thermal power generation: develop (ultra)-supercritical units, combined-cycle units, heat/power cogeneration, heat/power/coal gas multiple supply units
60	Utilise wind, solar, geothermal and tidal energy
50	Increase forest rate to 20 percent and enhance carbon sinks
50	Continue to promote nuclear energy
30	Promote bio-energy for power generation and fuels
1550	**TOTAL**

Table 2.1 Chinese estimates of avoided emissions, due to mitigation measures in *China's National Climate Change Programme*. Source: National Development and Reform Commission, *China's National Climate Change Programme*, June 2007.

The *National Climate Change Programme* also gives short term targets and policy objectives that should help to mitigate emissions. While many of these targets are part of earlier legislation, they are presented in the document as climate change policy complete with estimates of avoided greenhouse gas emissions (see Table 2.1).

2.2 A drive for energy efficiency

Energy efficiency and energy conservation improvements are globally recognised as being the most promising and cost-effective measures for reducing energy consumption and greenhouse gas emissions. This is particularly true for developing countries, which have a huge potential for energy efficiency gains and technological improvement.[67] In the Alternative Policy Scenario of the International Energy Agency, which assumes that vigorous action will be undertaken to limit emissions, energy efficiency would contribute 60 percent to all energy saved compared to their baseline scenario and could account for 69 percent of total avoided CO_2 emissions.[68]

Compared internationally, China's energy consumption per unit of GDP is still three times as high as the world average and almost five times as high as that in the OECD

[67] According to McKinsey, energy efficiency gains could lower worldwide emissions in 2020 by 14 $GtCO_2e$ (almost 30 percent of the total potential reduction). For developing countries, energy efficiency measures with positive returns on investment could lower energy demand by 22 percent in 2020 compared to business-as-usual scenarios. McKinsey & Company, *Pathways to a Low-Carbon Economy*, 2009, p. 11; McKinsey Global Institute, *Fueling sustainable development: The energy productivity solution*, October 2008, pp. 4, 8-10. Also see: McKinsey & Company, *China's Green Revolution: Prioritizing technologies to achieve energy and environmental sustainability*, 2009, pp. 9-18 and *McKinsey Quarterly*, 'Promoting energy efficiency in the developing world', February 2009.

[68] International Energy Agency, *World Energy Outlook 2007*, pp. 45, 370.

countries.[69] At the root of this inefficiency is the predominant share of energy-intensive industries in China's economy, combined with the often backward technological state of these industries. While industry accounts for almost 60 percent of the final energy consumption, energy intensity in industry is still 25 to 60 percent higher than the advanced international level; this holds especially for energy-intensive heavy industries like the production of steel, copper, aluminium, ammonia, plate glass and cement.[70] China thus offers an enormous potential for an increase in energy efficiency, which could make a great impact on the reduction of emissions.[71]

Energy efficiency and conservation in Chinese energy policy

Energy efficiency and conservation have been important elements of China's energy security strategy in the past. Due to strict energy conservation measures enacted in the early 1980s, China managed to quadruple its gross domestic product while only doubling its energy consumption, effectively lowering its energy intensity by 50 percent.[72] This has been hailed by experts as a quite extraordinary feat, given that in most industrialising countries energy consumption growth exceeds the growth of the economy.[73]

Emboldened by the success, China has reiterated the goal of quadrupling its gross domestic product and doubling its energy consumption for the period 2000-2020 in its long-term development plan. In the short term, the government set itself the binding target of reducing energy intensity by 20 percent in its 11th Five Year Plan running from 2005 to 2010. If successful, it is estimated that the effort would save about 1.5 billion tonnes of CO_2 emissions by 2010.[74]

In order to achieve its goals the government has launched the following measures:[75]

1) **The Top-1000 Enterprises Programme**: In this programme the thousand most energy-consuming enterprises in China are gathered together and led to agree on efficiency target commitments. Together these companies account for one-third of the national total energy consumption and 47 percent of industrial energy consumption. The government has supported energy efficiency audits and energy consulting at the companies, with the aim of implementing measures that yield

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[69] Based on nominal GDP figures. International Energy Agency, *Key World Energy Statistics 2008*.

[70] APERC, *APEC Energy Overview 2007*, 2008, p. 46. APERC, *Understanding Energy in China*, 2008, pp. 101-103. Potential energy efficiency gains in energy resource consumption per unit of output for various industries: coal-fired power (17%), steel (18%), copper smelting (56%), aluminium (38%), ammonia (25%), cement (14%), plate glass (44%), paper and paper products (120%).

[71] Emissions reduction strategies for China and the role of energy-efficiency will be also discussed in section 4.1.

[72] Sinton, J.E., Levine, M.D. and Wang, Q. 'Energy Efficiency in China: Accomplishments and challenges', *Energy Policy*, vol. 26, no. 11, 1998, pp. 813-829. Also see: State Council Information Office, *China's Energy Conditions and Policies* [White paper on Energy], December 2007, p. 7.

[73] IEA, *China's Worldwide Quest for Energy Security*, 2000, pp. 16-17.

[74] Lin, J., Zhou, N., Levine, M. and Fridley, D., 'Taking out 1 billion tons of CO_2: The magic of China's 11th Five-Year Plan?', *Energy Policy*, vol. 36, 2008, p. 954.

[75] A compact overview of Chinese policies on energy and climate can be found at: World Resource Institute, *Fact Sheet – Energy and Climate Policy Action in China*, 10 June 2009 (updated). Retrieved at http://pdf.wri.org/factsheets/factsheet_china_policy.pdf on 15 June 2009. Old version: 25 September 2008. Retrieved at http://pdf.wri.org/energy-climate_policy_action_in_china.pdf on 15 January 2009.

net profit due to energy savings. Preliminary results indicate that the programme is quite successful, and it is supposedly on target to make the 20 percent energy intensity improvement goal by 2010.[76]

2) **Vehicle Fuel Economy Standards**: With new legislation enacted in 2004, fuel economy standards in China (36 mpg) for new cars are more strict than those in the U.S. (30 mpg), Australia and Canada. Tax regulation has been adjusted to promote smaller and lighter vehicles.[77]

3) **Stricter Efficiency Standards in the Power Sector**: New large coal-fired power plants are required to be either supercritical or ultra-supercritical.[78] Outdated and inefficient plants are being replaced or shut down. By the first half of 2009 a cumulative 54 GW of capacity had been shut down since 2006, surpassing the 50 GW target for 2010.[79]

4) **Building Efficiency Standards**: A new building code has been issued, with higher standards on insulation and energy efficient design and a 50 percent overall energy efficiency improvement compared to earlier standards.[80]

5) **Fiscal Incentives**: Advantageous tax rebates for energy- and pollution-intensive industries are being revoked or readjusted. Preferential treatment is instead given to high-tech and services companies.

6) Energy Efficiency Labelling System: Mandatory labelling will be introduced for electrical appliances, lighting, vehicles and other consumer goods. Consumer awareness on energy consumption is being stimulated.

Challenges ahead

Impressive progress has been made, yet there are signs that it will be difficult, if not impossible, for the government to meet the ambitious targets it has set for itself. The downward trend of energy intensity over the period 1980-2000 came to a halt in 2002, with energy consumption showing a marked acceleration and growth rates soaring even above the growth of the gross domestic product – increasing energy intensity instead of lowering it. While the increase in energy efficiency during the two decades prior to 2000 was remarkable and a most laudable achievement, it seems that the current higher growth rate of energy consumption signals a return to a more traditional development pattern.[81]

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[76] Price, L., Wang, Xuejun (Lawrence Berkeley National Laboratory), *Constraining Energy Consumption of China's Largest Industrial Enterprises Through the Top-1000 Energy-Consuming Enterprise Program*, May 2007.

[77] APERC, *Understanding Energy in China*, 2008, pp. 108-109.

[78] This indicates that their power generation energy efficiency will be at least 40% and around 48%, respectively.

[79] Wong, J.L., ' Putting China's Coal Power Sector in its Proper Perspective', *The Green Leap Forward 绿跃进*, 31 July 2009. Retrieved at http://greenleapforward.com/2009/07/31/putting-chinas-coal-power-sector-in-its-proper-perspective/ on 28 August 2009.

[80] APERC, *Understanding Energy in China*, 2008, p. 109.

[81] Lin, J., Zhou, N., Levine, M. and Fridley, D., 'Taking out 1 billion tons of CO_2: The magic of China's 11th Five-Year Plan?', *Energy Policy*, vol. 36, 2008, p. 954, 958-959.

The target of only doubling energy consumption from 2000 to 2020 would imply a total energy consumption of around 2.78 billion tonnes of coal-equivalent (tce) by 2020. However, the most recent Chinese statistics indicate that China already consumed 2.66 billion tce in 2007, more than 95 percent of the amount allocated for 2020.[82] With growth having accelerated in recent years, it is safe to say that this goal will not be met.

As for the 20 percent energy intensity reduction target set for 2010 compared to 2005, the necessary annual decline should be around 4.3 percent. As the growth of energy consumption has been brought down again, yearly energy intensity reductions amounted to 1.7 percent in 2006, 3.7 percent in 2007 and 4.6 percent in 2008. Preliminary statistics showed a drop of 3.35 percent in the first half of 2009, partly due to the impact of the economic crisis and a slump in the output of heavy industries. Although the published statistics are still subject to revisions, the current data points out that energy efficiency improvements will need to be accelerated in order for China to meet its 20 energy intensity reduction target. Recent developments suggest that it will be difficult for China to achieve its goal and that the final energy intensity improvement might be around 15 or 16 percent.[83]

A key issue in achieving the energy efficiency targets is the enforcement of new regulations, a problem that plays a much broader role in China, ranging from intellectual property rights to environmental legislation. Case in point is the new regulation for the building sector, which should contribute 40 percent to the overall energy saved in the energy intensity reduction target. Heating energy consumption per unit of area in China is reported to be twice as high as advanced international levels, and the new legislation aims to erase this discrepancy. However, with construction in China moving forward at blinding speed, supervision by local governments is quite ineffective. In addition, low energy prices give little incentive to real estate developers and residents to heed this issue.[84]

2.3 Promotion of renewable energy sources

The developments in renewable energy receive a lot of attention yet deserve to be placed in the proper perspective. Globally, renewable energy accounts for only about 5 to 6 percent of the world's final energy consumption, with half of that supplied by large-scale hydropower projects. For China, renewable energy sources – with the exception of hydropower – still yield only a marginal share of less than 1 percent of China's primary energy consumption in absolute terms, or about 7.5 percent if hydropower is included.[85] In terms of power generation, hydropower supplies 16 percent of all electricity, while the remainder of renewables account for less than 1 percent.

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[82] National Bureau of Statistics, *China Statistical Yearbook 2008*. Also see: Fridley, D. 'Natural Gas in China', Chapter 2 in: Stern, J., *Natural Gas in Asia*, Oxford University Press, 2008, p. 43.

[83] Andrews-Speed, Philip, 'China's energy efficiency drive: is it sustainable?', Centre for Energy, Petroleum and Mineral Law and Policy Gateway, 17 August 2008; *Caijing Magazine*, 'Decline in Energy Intensity Won't Extend', 4 August 2009. Retrieved at http://english.caijing.com.cn/2009-08-04/110220301.html on 28 August 2009. On inconsistent reporting of Chinese energy intensity statistics see: Romankiewicz, J., 'Deconstructing China's Energy Intensity—A Lesson in Fuzzy Math', *The Green Leap Forward 绿跃进*, 11 August 2009.

[84] Levine, Mark D., and Aden, Nathaniel T. (Lawrence Berkeley National Laboratory), *Global Carbon Emissions in the Coming Decades: The Case of China*, May 2008, p. 20. APERC, *Understanding Energy in China*, 2008, pp. 108-109. According to recent statistics of the Chinese government though, the compliancy rate of

[85] IEA, WEO 2008, pp. 531-532; REN21, *Renewables 2007 Global Status Report*, 2008, p. 40. In this definition of renewable energy, traditional use of biomass is not included.

However, the role of renewable energy sources is set to quickly gain significance in coming years. China is one of the fastest growing markets for renewable energy in the world, and favourable government policies combined with the advantages of low-cost domestic manufacturing capacity are catapulting the development of renewable energy forward.

Targets for renewable energy and policy support

The conviction of president Obama that "the country that harnesses the power of clean, renewable energy will lead the 21st century" seems to be very much shared by the Chinese leadership. The Chinese government is making concerted efforts to establish a strong domestic industry for renewables and has declared the goal of increasing the share of renewable energy in the total energy consumption from 7.5 percent (2005) to 10 percent by 2010, and up to 15 percent in 2020.

Resource	**Total potential**	**2005**	**Target 2010**	**Target 2020**
Hydropower	400 GW (540)	117 GW	190 GW	300 GW
Biomass - biomass power - biomass pellets - biogas - bio-ethanol - bio-diesel	-	-	- 5.5 GW - 1m tonnes - 19bn m^3 - 2m tonnes - 0.2m tonnes	- 30 GW - 50m tonnes - 44bn m^3 - 10m tonnes - 2m tonnes
Wind power	300 GW onshore, 700 GW offshore	1.26 GW	5 GW onshore, 200 MW offshore	29 GW onshore, 1 GW offshore *(expected to be raised to 100GW)*
Solar power PV		70 MW	0.3 GW	1.8 GW
Solar thermal		80m m2	150m m2 (30 Mtce)	300 m2 (60 Mtce)
Geothermal power			4 Mtce	12 Mtce
Tidal power			-	100 MW

Table 2.2 China's renewable energy targets. Source: National Development and Research Commission, *Medium and Long Term Development Plan for Renewable Energy in China*, September 2007.

Table 2.2 lists the specific targets for various renewable energy sources by 2010 and 2020, as mentioned in the government's *Medium and Long Term Development Plan for Renewable Energy in China,* released in September 2007.

The necessary framework for the promotion of renewable energy sources has been laid out in the *Renewable Energy Law* (2005) and the *Medium and Long Term Development Plan for Renewable Energy in China* (2007). Following successful examples in Europe, the law stipulates feed-in tariffs for various renewable energy sources, regulates pricing and

fee sharing for on-grid renewable energy sources, offering financial incentives such as tax breaks for renewable energy developers. Moreover, the law mandates a renewable energy portfolio standard, obliging state power grid companies to purchase and connect to renewable power sources, and for gasoline wholesale companies to purchase liquid bio-fuels.[86]

Hydropower

In retrospect, the promotion of hydropower in the second half of the twentieth century has been one of the most important developments in the mitigation of China's greenhouse gas emissions. Hydropower's 21 percent share in the total power capacity now generates about 16 percent of China's electricity demand – a significant amount, considering that the remainder of all electricity in China is generated almost exclusively using coal, with concomitant high carbon dioxide emissions.

China is already the world largest producer of hydropower, yet it is still increasing its capacity at the frantic pace of about 8 percent per year, compared to the world average growth of 3 percent. The most recent high profile project has naturally been the massive Three Gorges Dam in the Yangtze River, which has a generating capacity of 22.5 GW (as much as all other renewable energy sources combined). Several large dams upstream on the Yellow River have also commenced operation, which will generate about 15.8 GW in total.[87]

Even with an increasing scarcity of suitable locations for hydropower, China has still managed to keep its hydropower expansion on par with its rapidly growing power sector, adding 4-6 GW of small hydro annually since 2004 plus another 12-15 GW of large hydro capacity in 2008 alone. A few of the major projects now under construction are the Xiangjiaba dam on the Jinsha River (6.4 GW) and the Xilodu dam (12.6 GW) in south-western China.[88]

The massive and rapid expansion of hydropower may very well grind to a halt in one or two decades, however. While the government has set a target of 300 GW of installed hydropower capacity by 2020, the total economically feasible potential for hydropower is estimated to be around 400 GW, with a technically feasible upper limit of 540 GW.[89] It worthwhile to contrast this with the total power generation capacity in China, i.e. from *all* sources (including hydropower). Considering that China already had a total installed capacity of around 800 GW in 2008 and about 1400 GW of total capacity is projected for 2020, even the impact of hydropower will eventually be limited in reducing the dominance of coal in China's power sector in the long run.

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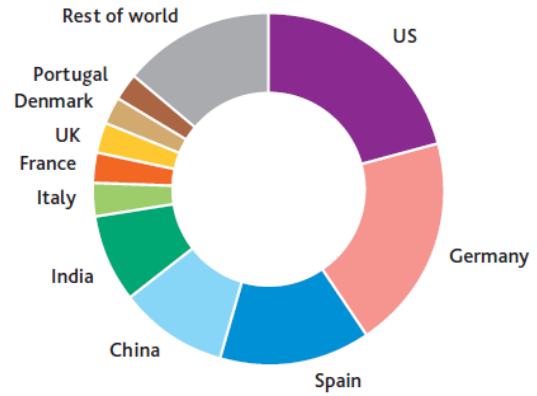
[86] Martinot, Eric, and Li, Junfeng, *Power China's Development. The Role of Renewable Energy,* Worldwatch Institute, November 2007. For a discussion of the *Renewable Energy Law* and the *Medium and Long Term Development Plan for Renewable Energy in China* see: Li Zijun, 'China's Renewable Energy Law Takes Effect; Pricing and Fee-Sharing Rules Issued', *Worldwatch Institute*, 18 January 2006; *China Environmental Law,* 'China's Renewable Energy Law',27 March 2008, and 'China's Renewable Energy Law (Policies & Plans)', 13 April 2008.

[87] *International Water Power & Dam Construction Magazine*, 'Beyond Three Gorges in China', 10 January, 2007. Retrieved at http://www.waterpowermagazine.com/story.asp?storyCode=2041318 on 20 May 2009.

[88] REN21, *Renewables 2007 Global Status Report*, 2008, p. 10.

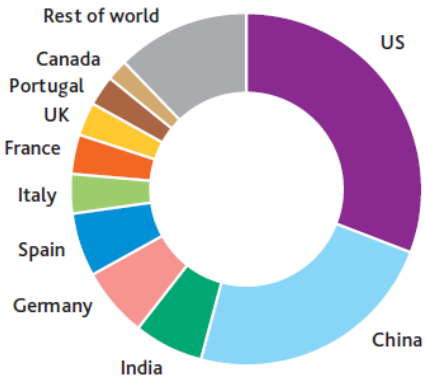
[89] National Development and Research Commission, *Medium and Long Term Development Plan for Renewable Energy in China* (draft), September 2007, paragraph 1.1.1. The white paper on energy, however, mentions that only 20 percent of the country's hydropower resources have been utilised so far. State Council, *China's Energy Conditions and Policies* [White Paper on Energy), December 2007, section IV.

TOP 10 TOTAL INSTALLED CAPACITY 2008



	MW	%
USA	25,170	20.8
Germany	23,903	19.8
Spain	16,754	13.9
China	12,210	10.1
India	9,645	8.0
Italy	3,736	3.1
France	3,404	2.8
UK	3,241	2.7
Denmark	3,180	2.6
Portugal	2,862	2.4
Rest of world	16,693	13.8
Total top 10	**104,104**	**86.2**
World total	**120,798**	**100.0**

TOP 10 NEW CAPACITY 2008



	MW	%
USA	8,358	30.9
China	6,300	23.3
India	1,800	6.7
Germany	1,665	6.2
Spain	1,609	5.9
Italy	1,010	3.7
France	950	3.5
UK	836	3.1
Portugal	712	2.6
Canada	526	1.9
Rest of world	3,285	12.2
Total top 10	**23,766**	**87.8**
World total	**27,051**	**100.0**

Table 2.3 Wind power status in 2008.
Source: Global Wind Energy Council, *Global Wind Report 2008,* January 2009, p. 9.

Status of other renewables – Wind energy

Compared to hydropower, other renewable energy sources still play a marginal role, totalling only 5 percent of all 'renewable' electricity generated and satisfying less than 1 percent of the total electricity demand. Yet the rapid growth in these sectors and their potential impact on future energy supply has attracted international attention.

In particular, much attention has been given to wind energy. After a decade of rapid growth of almost 50 percent per year, growth has accelerated even more in the past few years. In 2008 China managed to double its installed wind power capacity for the fourth year in row, ranking it second behind the United States in terms of newly installed capacity in that year. Total capacity surged upwards from 1.3 GW in 2005 to 2.7 GW in 2006, 5.9 GW in 2007 and 12.2 GW in 2008.[90] This has also meant that China has shot up in the ranks of total installed capacity worldwide. It is now fourth in the world, behind

[90] Global Wind Energy Council, *Global Wind Report*, 2008, pp. 10,24-25; Global Wind Energy Council, 'US and China in race to the top of global wind industry', 2 February 2009.

only the United States (25.2 GW), Germany (23.9 GW) and Spain (16.8 GW), having surpassed India last year.

Growth in wind industry has had much to do with government support. The Chinese state has issued a multiple-round concessions bidding system for large-scale projects, which has been very successful in spurring competition among wind farm developers. The main problem has been that final tenders have been priced too low to actually be able to economically develop the considered projects. Another problem encountered in the extremely rapid expansion of wind power has been that grid companies have been unable to meet their obligations under the *Renewable Energy Law* to connect to newly established wind farms, especially since many of them are located in the far-off northwestern provinces where most of China's onshore wind resources are located. Nonetheless, the policies have been very effective overall in encouraging the growth of wind energy in China (see Table 2.3).

A second aspect and very successful achievement of the Chinese government policies has been the establishment of a strong domestic wind power industry. One key policy issue in this respect has been the requirement that 70 percent of the total value of the components used for wind turbines should be manufactured locally in China. As the wind market used to be dominated by foreign wind turbine manufacturers like Vestas (Denmark), GE Energy (US), Gamesa (Spain) and Nordex (Germany), this requirement has forced these companies to establish subsidiaries in China. In addition, a whole wave of local manufacturers have sprung up, which increased their market share from 25 percent in 2004 to 56 percent in 2007. While many of these companies have only been involved in the domestic market, it is only a matter of time until they become important global players, as their production capacity and technological level is catching up with that of their advanced competitors.[91] Among the more than 40 Chinese wind turbine manufacturers, the largest companies and their respective market shares are: Goldwind (33%), Sinovel (6%), Zhejiang Windey (1.5%) and DEC (0.8%).[92] The wind farm developers are mainly the large state-owned power companies and grid companies.

As for future growth, the wind energy market in China is outpacing all projections as well as government targets. Since the government has indicated that it considers wind energy to be one of the key economic growth areas, expectation for further growth is very positive despite the economic crisis. As recently as September 2007, the National Development and Reform Commission set the 2010 target for installed wind capacity at 5 GW in its *Renewable Energy Mid and Long Term Development Plan,* later doubled to 10 GW. For 2020 the target has been set at 30 GW, but with the current explosive growth pattern this target will already be met in about three years' time. Installed capacity is projected to nearly double again in 2009, bringing China close to the second place in the global ranking list. Currently the government is considering raising the 2020 target to 100 GW or even 150 GW, a three- to five-fold increase.[93]

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[91] Global Wind Energy Council, *Global Wind Energy Outlook 2008,* October 2008, p. 20.

[92] Martinot, Eric, Li, Junfeng, 'Powering China's Development: The Role of Renewable Energy', *Renewable Energy World*, January/February 2008.

[93] Zhang Guobao, NDRC, 'China's Wind Power Generation Capacity in 2020 Could Exceed Government Target', 31 December 2008. Retrieved at http://cdm.ccchina.gov.cn/english/NewsInfo.asp?NewsId=3251 on 10 January 2009.

Solar power

Solar power plays only an extremely marginal role in renewable energy in terms of installed capacity worldwide, and this is even more true for China. Total installed capacity of solar photovoltaic (PV) systems in China was about 80 MW in 2006, compared to 7700 MW worldwide. Despite its small size, solar energy in China has attracted much attention and investment, and in only a few years' time more than 15 major Chinese solar cell manufacturers have emerged. In contrast to wind energy, the solar manufacturing industry in China is almost completely geared towards export: production capacity of 1 GW is far exceeding the domestic market growth of about 10 MW per year.[94] Moreover, production capacity has been expanding quickly, with China surpassing the United States in 2006.[95]

The emergence of Suntech as a top global manufacturer has been exemplary for the rapid development of the solar energy industry in China. Set up in 2002 with only one production line of 10 MW and a local government loan of US$6 million, it successfully gained large sums of foreign investment by its initial public offering on the New York Stock Exchange and rapidly expanded its production capacity to 270 MW in 2006 and 470 MW in 2007, with plans of expanding it further to circa 1 GW. As a result, the company currently ranks as the world's fourth largest manufacturer of solar cells and panels, closely behind the German Q-Cells and Japanese companies Sharp and Kyocera.[96] Symbolising its success, its founder Shi Zhengrong was listed in 2006 as the wealthiest Chinese person on the mainland by the business magazine *Forbes*.

The official target for solar energy in China has been set at 1.8 GW for 2020, but this target, too, might be revised upward. Some officials have mentioned that 10 GW or even 20 GW might be achievable by 2020.[97] While half of China's domestic deployment of solar PV has been for rural off-grid purposes, several large solar PV grid-connected projects have been launched in recent years, with individual project sizes running from 10 MW to 166 MW.[98]

However, the solar energy industry is badly affected by the economic crisis. Although China's solar panel production capacity was projected to reach more than 4 GW by 2010 (which would be more than the global production capacity of 2006), the financial crisis has forced many companies to cancel or postpone some of the more ambitious expansions plans. Reportedly, one-fifth of all solar cell and components manufacturers

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[94] The production capacity of 1 GW and market growth of 10 MW are over 2006. Martinot, Eric, Li, Junfeng, 'Powering China's Development: The Role of Renewable Energy', *Renewable Energy World*, January/February 2008.

[95] REN21, *Renewables 2007 Global Status Report*, 2008, pp. 18-19; Martinot, Eric, Li, Junfeng, 'Powering China's Development: The Role of Renewable Energy', *Renewable Energy World*, January/February 2008.

[96] REN21, *Renewables 2007 Global Status Report*, 2008, pp. 18-19; Martinot, Eric, Li, Junfeng, 'Powering China's Development: The Role of Renewable Energy', *Renewable Energy World*, January/February 2008.

[97] Wang Zhongying, Assistant Director and Head of the Renewable Energy Development Centre at the Energy Research Institute of the National Development and Research Commission. 'China solar set to be 5 times 2020 target', *China Climate Change Info-Net*, 7 May 2009. Retrieved at http://www.ccchina.gov.cn/en/NewsInfo.asp?NewsId=17276 on 18 May 2009.

[98] The largest projects planned are a 166 MW solar plant in Yunnan and a 10 MW plant in Dunhuang. *China Daily,* 'Energy sector rises to the challenge', 16 February 2009. Retrieved at http://www.chinadaily.com.cn/bizchina/2009-02/16/content_7478558.htm on 18 February 2009; *China.org.cn,* '10 cents/kWh, world's cheapest solar energy?', 26 March 2009. Retrieved at http://www.china.org.cn/environment/news/2009-03/26/content_17504686.htm on 4 April 2009.

have closed. The largest manufacturer, Suntech, suffered huge losses in the fourth quarter of 2008, forcing it to lay off one-tenth of its staff and lowering production output to 50 percent of maximum capacity. Yet even in this economic turmoil, the Chinese companies receive the benefit of solid financial backing by state-owned banks, which have massively increased lending in support of the government's stimulus programme. Although expansion plans have been reined in, the government support for the renewable energy sector is thought to be sufficient to allow the solar companies to weather the storm.[99]

Biomass and biofuels

Power generation from biomass is targeted to reach 5.5 GW in 2010 and 30 GW in 2030. With an annual production of 400 to 800 million tonnes of agricultural and forest waste that theoretically could be used as feedstock, the potential for growth is quite large. Yet up to now this sector has developed very slowly, with only 2 GW of biomass power plant capacity having been installed, mainly feeding upon waste from sugar cane and rice production.

Liquid biofuels for transportation have gained in attention as a measure to limit China's oil dependency, yet the limited availability of fertile land hampers the development of this sector. With only one-fifteenth of its land area being suited for agricultural production, domestic food production is already exerting a large pressure on the agricultural sector.[100] Due to these concerns the expansion of production of ethanol from corn has been prohibited, even though ethanol producers received subsidies in earlier years. Biodiesel which can be produced from agricultural waste and vegetable oils are an alternative for transportation fuel production, but developments in this sector are also still quite small-scale.[101]

Rural application of renewables

Making use of renewable energy sources in rural areas can be a very successful way to contribute to sustainable development, making it a win-win solution toward the objective of raising rural living standards and expanding rural electrification.

China has already made very good use of this potential. One key achievement is the widespread implementation of small-scale hydropower in suitable areas, with total capacity adding up to 47 GW – about 64 percent of the world's small hydro installations.[102] A second major achievement is the large-scale deployment of solar hot water and solar heating systems, in which China occupies two-thirds of global installed capacity. While growth of this market has been purely on economic grounds without government support, new policies and building practices mandating use of these systems are expected to keep market growth at 20 to 25 percent per year, increasing the use in urban areas as well. Currently there is 100 million m^2 of installed solar hot water

[99] *Caijing Magazine,* 'Cloudy Forecast for China's Solar Pacesetter', 6 March 2009.

[100] Food and Agriculture Organization of the United Nations (FAO), *Agricultural Policy and Food Security in China*, Annex 3 in: FAO, *Poverty Alleviation and Food Security in Asia: Lessons and Challenges*, 1999.

[101] Martinot, Eric, and Li, Junfeng, *Power China's Development. The Role of Renewable Energy,* Worldwatch Institute, November 2007, pp. 28-31.

[102] REN21, *Renewables 2007 Global Status Report*, 2008, p. 38.

systems, which serve approximately 10 percent of all Chinese households and contribute to a reduced electricity demand.[103]

2.4 Nuclear energy in China

The pursuit of nuclear energy is another avenue through which China is trying to limit its dependency on coal-fired electricity generation. Construction of nuclear power reactors is strongly being promoted and accelerated, which has made China the largest growing nuclear market overnight. China currently has 8.6 GW of nuclear power capacity, with eleven reactors in operation. However, as of May 2009 twelve more reactors were already under construction: more than one-third of the thirty new reactors under construction worldwide.

Only very recently the target of having 40 GW of installed nuclear capacity in 2020 was considered by many experts as too optimistic and ambitious, since it implied an additional 2.5 GW of capacity to be installed annually up to 2020 – an expansion level that was considered difficult to obtain.[104] Yet nuclear reactor construction has shot up in China. In May 2009 twelve reactors were under construction, with construction of another twelve reactors about to begin in 2009. Taken together with additional projects scheduled to start in 2010 and 2011, the combined output will add more than 47 GW to the existing nuclear power generating capacity.[105] In comparison, the scope of this expansion is nearly the size of Japan's total nuclear power capacity of 48 GW – which is currently the world's third largest installed nuclear capacity behind the United States (99 GW) and France (63 GW).

The National Development and Research Commission is reported to be considering an upward revision of the target. A target of 60 GW or 70 GW by 2020 seems likely, which would denote an increase that is perhaps more than 50 percent above the original target. This expansion should then achieve the goal of meeting 5 percent of electricity demand by nuclear power, set by the new National Energy Bureau in March 2008.[106]

The development of a domestic nuclear industry

As with the renewable energy sector, China's key objective regarding nuclear energy is to develop its own indigenous industry. It strives to attain reactor design and construction capabilities, in particular for advanced third generation reactors and fast neutron breeders. Technology transfer with respect to foreign nuclear technology has been the recurring theme in China's nuclear energy development: its first few reactors were built in the late 1980s and 1990s with foreign assistance and French, Canadian and Russian technology. Already from these first joint initiatives, China successfully

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[103] However, estimates of avoided carbon dioxide emissions are still rather low, at 15 million tonnes of CO_2 annually – about 0.25 percent of China's total greenhouse gas emissions in 2004. Martinot, Eric, Li, Junfeng, 'Powering China's Development: The Role of Renewable Energy', *Renewable Energy World*, January/February 2008.

[104] Fridley, D. 'Natural Gas in China', Chapter 2 in: Stern, J., *Natural Gas in Asia*, Oxford University Press, 2008, p. 59.

[105] *World Nuclear Association,* 'Nuclear Power in China', updated 18 May 2009. Retrieved at http://www.world-nuclear.org/info/inf63.html on 20 May 2009.

[106] *China Daily*, 'Energy sector rises to the challenge', 16 February 2009. Retrieved at http://www.chinadaily.com.cn/bizchina/2009-02/16/content_7478558.htm on 16 April 2009; *China Daily*, 'Green energy projects increase', 30 March 2009. Retrieved at http://www.chinadaily.com.cn/bw/2009-03/30/content_7627892.htm on 23 April 2009.

mastered the design and construction skills needed for pressurised water reactors based on French technology, although critical components like turbines and reactor pressure vessels have often still been supplied by foreign partners.[107]

The first two nuclear reactors in China went into commercial operation in 1994 at Daya Bay near Hong Kong, construction having started in 1987. Reactor design used Framatome pressurised water reactor technology. Chinese engineers participated in the construction, which was supervised by Electricité de France; technology and various components were supplied by Framatome and GEC-Alstom. Almost simultaneously, China's first indigenously designed and constructed nuclear power plant was being built at Qinshan in the Zhejiang province: a small 280 MW pressurised water reactor.

Following these first reactors, China introduced its own CPR-1000 pressurised water reactor at Lingao in 1997. The design was virtually a replica of the Daya Bay reactors, with Framatome still supplying part of the technology. This type of CPR-1000 reactor has subsequently become the mainstay of the Chinese domestic nuclear industry, accounting for 26 of the 45 reactors under construction or planned as of April 2009.

More nuclear power plants brought Canadian and Russian nuclear technology to China. Two additional reactors at Qinshan were built with CANDU-6 pressurised heavy water reactor technology purchased from Atomic Energy of Canada. A Russian AES-91 power plant with two 1060 MWe VVER reactors was constructed at Tianwan in Jiangsu province, coming into commercial operation in August 2007.

The pursuit of third-generation reactor technology

China's 11th Five-Year Plan (2006-2010) included plans for the construction of four nuclear reactors based on advanced nuclear technology at two designated sites in China. The selection of the foreign partners was done through an open international bidding process, in which the technology selection process was in the hands of the State Nuclear Power Technology Corporation, an entity falling directly under China's State Council. Apart from factors such as price, local content and the technological level, the most crucial aspect for the evaluation of the bids was the level of technology transfer.

Major international nuclear energy companies all submitted bids: Westinghouse (with its AP1000 reactor design), Areva (EPR) and Atomstroyexport (a V-392 version of the VVER-1000). Based on their third-generation technology, Areva and Westinghouse were short listed, with the final contract going to Westinghouse in mid-2007 for all four reactors. Technology transfer is being assured through means of several Chinese companies supplying major components like reactor vessels and steam generators. In addition, Westinghouse signed an agreement with the Chinese on technology transfer to enable them to build further AP1000-based units on their own. For this purpose, Westinghouse is cooperating with the Shanghai Nuclear Engineering Research & Design Institute (SNERDI), which is responsible for the first indigenously designed Chinese reactors. Research focuses on an enlarged 1400 MWe version of the AP1000 for large-

[107] For instance, Alstom has been involved in supplying turbines to Chinese reactors, Mitsubishi in pressure vessels and Framatome in PWR technology. Framatome is a subsidiary of Areva.

scale deployment in China and possible export in cooperation with Westinghouse.[108] Second, a special research centre was set up in Beijing by Tsinghua University and the State Nuclear Power Technology Corporation with a particular focus on the adaptation and assimilation of the Westinghouse AP1000 reactor design.[109] Apart from the first four reactors included in the bidding round, six more AP1000 reactors have been selected for construction at various sites, with almost twenty more reactors in the planning phase.

For Areva and Atomstroyexport, the unsuccessful bids have been compensated by other smaller contracts. Atomstroyexport is expected to build another two AES-91 reactors at the Tianwan site, while Areva signed a contract with the China Guangdong Nuclear Power Group in November 2007 for the construction of two 1650 MWe EPR units at Taishan in Guangdong, combined with agreements on fuel supply and other services. In order to accommodate the technology transfer requirements, both parties created an engineering joint venture in 2008 to engineer and procure equipment for both the EPR and the Chinese CPR-1000 reactor, in which the Chinese side holds 55 percent versus Areva's 45 percent.

Acquiring third-generation technology for large advanced pressurised water reactors is one of the key goals of China's nuclear energy programme, which aims to make pressurised water reactors the main reactor type in China. Second to this, China also aims to master technology for small high temperature gas-cooled reactors: a demonstration reactor of this type of 200 MWe was approved in 2005 and will be built at Shidaowan in Shandong province by a consortium led by China Huaneng Group, China's largest power generating utility.

Uranium supplies and fast breeder reactors

China currently produces about 840 tonnes of uranium per year, from a handful of mines located in the Guangxi, Xinjiang, Shaanxi and Liaoning provinces. This supplies about half of all the uranium needed by China's nuclear reactor fleet, with the remainder mainly imported from Kazakhstan, Russia, Namibia and Australia. Investment in new mining capacity has increased domestically as well as internationally.

As China's known uranium resources of 70,000 tonnes of uranium are not abundant enough to fulfil its nuclear ambitions, China is also keen on developing technology for fast neutron breeder reactors, which can be used to 'breed' plutonium and thus prolong the effective nuclear fuel supplies. As Chinese analysts expect fast reactor technology to become mainstream by mid-century, this goal can be seen as the third longer-term objective of China's nuclear programme. A small-size (65 MW) experimental fast neutron reactor has been built at the China Institute of Atomic Energy in Beijing with Russian assistance, scheduled to start operation at the end of 2009.[110]

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[108] The international companies in the field of nuclear energy are seriously reckoning with a strong Chinese competitor entering the market in the coming two decades. *Clingendael International Energy Programme,* CIEP Energy Policy Meeting: 'A Nuclear Renaissance', 4 December 2008.

[109] *World Nuclear News*, 'Research base for new Chinese nuclear power', 30 October 2008. Retrieved at http://www.world-nuclear-news.org/NN_Research_base_for_new_Chinese_nuclear_power3010081.html on 10 April 2009.

[110] *Xinhua News*, 'China to build commercial fast reactor by 2035', 8 June 2006. Retrieved at http://www.china.org.cn/english/scitech/170802.htm on 10 April 2009; *World Nuclear News*, 'Chinese fast reactor

2.5 Participation in the Clean Development Mechanism

After a hesitant start, China has become one of the most active participants in the Clean Development Mechanism under the Kyoto Protocol. The Clean Development Mechanism has been set up as one of the three flexible mechanisms under the Kyoto Protocol that allow countries with binding emissions reduction commitments, i.e. Annex-I countries, to invest in greenhouse gas emission reduction projects in non-Annex-I countries. This aims to serve a double purpose: first, the developed Annex-I countries can claim Certified Emissions Reductions (CERs) to assist them in complying with their binding greenhouse gas emissions reduction commitments at home. Second, it should stimulate sustainable development in the developing countries grouped in the non-Annex-I list.

While the Kyoto mechanisms were previously seen as instruments with which the developed countries could evade their commitments, the Chinese government came to realise the potential benefit of the Clean Development Mechanism (CDM) and established the first national framework for CDM in 2004 to manage the Chinese CDM projects. A leading role is played by the National Development and Reform Commission (NDRC) that acts as the Chinese 'Designated National Authority' for the CDM management. The NDRC co-chairs the Chinese CDM Approval Board, together with the Ministry of Science and Technology (MOST). In addition, a National CDM Management Center has been set up at the NDRC's Energy Research Institute.[111]

In a short span of time, the approval procedure has become reasonably streamlined, leading to a large influx of applications. As a result, China has captured an enormous share of the world's CDM market, growing from an entry-level participant to the market leader in just a few years' time. China has a current share of 47 percent of the total Certified Emissions Reductions (CERs) issued by international registered CDM projects. This dominant role is set to increase even further, as almost 60 percent of the expected global annual Certified Emissions Reductions from projects in the process of being validated at the UNFCCC originate from China.[112]

The rapid growth of allocated CERs has benefited from a strategic selection of CDM projects in China. As an example, initial Chinese CDM projects have focused on the reduction of the hydrofluorocarbon HFC-23, which is produced as a by-product of gases mainly used for refrigeration. HFC-23 is an extremely potent greenhouse gas with a global warming potential of 11,700 times that of carbon dioxide, meaning that just a few emission reduction projects yield large amounts of CERs. Moreover, China is a big producer of these gases and cutting these emissions can be done at low cost: at less than US$1 per tonne of CO_2-equivalent, which is less than a tenth of the value of the generated

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nears commissioning', 7 April 2009. Retrieved at http://www.world-nuclear-news.org/NN-Chinese_fast_reactor_nears_commissioning-0704095.html on 17 April 2009.

[111] Heggelund, Gørild 'China's Climate Change Policy: Domestic and International Developments', Asian Perspective Vol. 31, No. 2, 2007, pp. 179-187.

[112] Swank, Othmar and Guyer, Madeleine, 'CDM in China: Contribution to National and International Goals of Climate Policy', Conference Paper – CDM in China (Zurich, 2008), January 2009. Statistics from UNFCCC. Retrieved at http://cdm.unfccc.int/Statistics/Registration/AmountOfReductRegisteredProjPieChart.html on 1 June 2009.

CDM credits. As a result, HFC-23 reduction projects accounted for 72 percent of the total CERs allocated to China by 2007.[113]

The portfolio of CDM projects in China is set to change, however, since about one-third of the projects in the pipeline relate to renewable energy development. The two main pillars of this development are hydro and wind. According to the Global Wind Energy Council, 314 wind farm projects are in the pipeline for CDM approval, with a combined capacity of almost 17 GW – more than half of the total capacity of 25 GW of global wind power projects developed with support of CDM. Projects on energy efficiency, biomass and fossil fuel switching projects are also set to increase significantly.[114]

A particularly promising area for expansion of CDM projects is the development of coal-mine/coal-bed methane. Due to its large coal reserves, China possesses extensive quantities of coal-bed methane. Reserves are estimated at 36 trillion cubic metres (tcm), which according to a national survey in 1994 would put them almost on par with China's estimated total natural gas resources.[115] As methane is a greenhouse gas 21 times as potent as CO_2, utilisation of coal-bed and coal-mine methane would cut back significantly on China's greenhouse gas emissions while at the same time offering additional energy resources to China's tight domestic supply situation.[116] The government has created the China United Coalbed Methane Corporation (CUCBM) to play a central role in the development of China's coal-bed methane resources and has issued various favourable policies such as tax exemptions. Despite these efforts and the abundant potential for development, progress in exploitation has been rather slow to date. The production in 2007 was about 200 million cubic metres, in contrast to an earlier goal of 3-4 bcm. The official target for future development is still set at 10 bcm in 2010 and 20 bcm in 2015. Participation in the CDM process could give a positive stimulus to the development of coal-bed methane; and international attention has increased in recent years, leading to a series of projects being initiated in 2006 and 2007. An exemplary project has been the construction of a new CBM-fired 120 MW power plant at Jincheng in Shanxi province, the largest of its kind in Asia, with the assistance of $150 million in carbon credits.[117]

The extensive participation of China in the Clean Development Mechanism programme has not always been welcomed positively, however. As China has attracted about half of all issued CERs through its CDM projects, other developing countries have felt neglected and excluded in this mechanism. How to work towards a more evenly distributed geographic spread of CDM projects is certainly one of the key issues to be discussed in Copenhagen.

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[113] International Energy Agency, World Energy Outlook 2007, pp. 314-315. Swank, Othmar and Guyer, Madeleine, 'CDM in China: Contribution to National and International Goals of Climate Policy', Conference Paper – CDM in China (Zurich, 2008), January 2009, pp. 5-6.

[114] Global Wind Energy Council, *Global Wind Report 2008*, p. 3. Swank, Othmar and Guyer, Madeleine, 'CDM in China: Contribution to National and International Goals of Climate Policy', Conference Paper – CDM in China (Zurich, 2008), January 2009, pp. 5-6.

[115] Fridley, D. 'Natural Gas in China', Chapter 2 in: Stern, J., *Natural Gas in Asia*, Oxford University Press, 2008, pp. 10-14. These estimates all refer to *potential* reserves, not *proven* reserves. China's proven natural gas reserves stood at 2.46 tcm (end 2008). BP, *Statistical Review of World Energy*, June 2009.

[116] Methane emitted from coal mines contributes 8 percent to the world's total methane emissions. In China, coal mines emitted approximately 13.5 billion cubic metres of methane in 2004, ranking as the primary source of Chinese methane emissions. Delhotal, C., Jemelkova, B., 'Recovery and Use of Methane from Coal Mines in China', *China Environment Series*, Woodrow Wilson Center, 2008, pp. 69-70.

[117] Fridley, D. 'Natural Gas in China', Chapter 2 in: Stern, J., *Natural Gas in Asia*, Oxford University Press, 2008, p. 14.

A second point of discussion will be how to expand the Clean Development Mechanism in order to increase its impact. By the end of 2008, CERs allocated to China amounted to 5.5 million tonnes of CO_2e. Compared to the energy intensity reduction target in China's 11th Five Year Plan that is estimated to avoid 1.5 billion tonnes of CO_2e, this is a quite insignificant amount (only 0.4 percent).[118] The percentage is set to increase due to the large amount of projects in the CDM pipeline and might reach about 8 percent by 2010, but this would be a quite modest contribution to the climate change mitigation objectives. In fact, the 112 Mt CO_2e of CERs expected by 2010 would only amount to 1.8 percent of China's total greenhouse gas emissions of 6.1 billion tonnes of CO_2e in 2004.[119]

However, the suggested expansion of the CDM system is sure to draw objections as well. The difficulty in assessing the additionality condition, which requires that projects would not have been executed without the financial revenues of the issued CERs, has led to much criticism – especially from the United States, where CDM has been derogatively termed by some as the 'China Development Mechanism'. A report on climate change and foreign policy by the U.S. Council on Foreign Relations mentions: "The CDM has, for a variety of reasons, been largely unsuccessful in encouraging real and significant changes in developing countries."[120] Hence, the key words *measurable, reportable* and *verifiable* which came out of the COP-13 Bali conference will be sure to resurface in any discussion on the future of the Clean Development Mechanism.

[118] See Table 3.2 in Chapter 3, section 2.

[119] Swank, Othmar and Guyer, Madeleine, 'CDM in China: Contribution to National and International Goals of Climate Policy', Conference Paper – CDM in China (Zurich, 2008), January 2009, p. 10.

[120] U.S. Council on Foreign Relations, *Confronting Climate Change: A Strategy for U.S. Foreign Policy,* 2008, p. 5.

3

China's position in the climate treaty negotiations

China's standpoint at the international conferences on climate change over the past two decades has been unwavering. Even though pressure has been mounting for China to yield to demands for strong commitments given the continuous increase of Chinese emissions, China has been painstakingly consistent in its negotiating position and has always maintained that it will not commit to binding emission reduction targets.

In this chapter we will discuss the broader participation of China in the UNFCCC process and the current official line on the climate treaty negotiations. In addition, we will deal with China's proposal to the UNFCCC and investigate possible openings in the negotiations.

3.1 China's participation in the UNFCCC and Kyoto Protocol

Over the course of the past two decades, China has become thoroughly involved in the climate change programme under the United Nations. It signed the United Nations Framework Convention on Climate Change in 1992, at a time when its CO_2 emissions were only 2.5 Gt – about half of the United States' total.[121] It played an active role in the negotiations on the Kyoto Protocol and subsequently was one of the early signatories to the Protocol in 1998. It ratified the treaty in August 2002 as a non-Annex-I country, implying that it bears no legally binding targets to limit its greenhouse gas emissions.

In the course of the negotiations running up to the Kyoto Protocol and afterwards, China solidly positioned itself in this developing nations camp, acting in concert with the Group of 77 (G-77), which unites 130 developing countries in the United Nations political arena.[122] China has been one of the leading voices within this group, whose main argument in the negotiations has centred around the key phrase of "common but differentiated responsibilities" as written down in Article 10 of the Kyoto Protocol.[123]

For developing countries this phrase has been the centrepiece of the resistance to any stringent emission limits in the climate treaty negotiations, as they argue that for them the overriding priority lies with poverty eradication and economic development. China has been very successful in propagating this argument, and within the G-77 group it has gained a reputation for being a shrewd and well-prepared negotiator.[124] For China, however, the participation in the G-77 group serves a dual purpose. Apart from giving it more leverage in the climate treaty negotiations, it protects China from attempts to

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[121] Stern, Todd, U.S. Climate Change Lead Negotiator, speech at the Center for American Progress, 3 June 2009.

[122] See: www.g77.org. The Group of 77 includes China and India, but in U.N. context is often referred to as the "G77/China" or "G77+China" group.

[123] Jakobsen, Linda ,'China's Changing Climate', *The World Today,* May 2009.

[124] Heggelund, Gørild, 'China's Climate Change Policy: Domestic and International Developments', Asian Perspective Vol. 31, No. 2, 2007, pp. 175-179.

single it out and give it a different commitments compared to other developing countries.[125]

In addition, its categorisation as a non-Annex-I country, combined with the refusal of the United States to ratify the Kyoto Protocol, did give China a comfortable position in which it was able to deflect most criticism that it should commit to reduction targets as one of the world's largest economies and carbon emitters.

In fact, China has capitalised on the opportunity offered to confirm its image as a responsible stakeholder in the international political arena by being quite proactive in the climate change discussions held under the Conference of the Parties meetings in past years. Prior to the thirteenth Conference of the Parties (COP-13) in Bali, it presented its *National Climate Change Programme* and has succeeded in drawing public attention to the programme and gaining international acclaim with it.[126]

Praise for the Chinese programme on climate change has even extended to Western media and political circles, the prime example being President Obama, who lauded China as having the launched "the largest effort in history to make their economy energy efficient", in his address to the Congress shortly after taking office.[127] Also Todd Stern, the lead negotiator on climate change for the United States, has remarked that "[t]he Chinese are doing a lot already".[128]

Signs of further engagement in the UNFCCC process are given by the large-scale participation of China in the Clean Development Mechanism, which was instigated under the Kyoto Protocol to achieve sustainable development goals in developing countries while offering more effective mitigation options for developed countries.

3.2 China's current negotiation stance: the official line

While China has responded favourably to the final entry into force of the Kyoto Protocol and launched a domestic programme addressing climate change, it has consistently maintained its opposition to mandatory emission reductions. This opposition has relied on the following couple of arguments:

Historically, China has contributed very little to the current accumulated greenhouse gases in the atmosphere, hence it is not the responsibility of China to "clean up the mess".

China points out that according to historical emissions statistics it has contributed only 8 percent to the total accumulated energy-related CO_2 in the atmosphere since 1900. At

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[125] Lewis, Joanna I., 'China's Strategic Priorities in International Climate Change Negotiations', *The Washington Quarterly*, Winter 2007-2008, pp. 161-163.

[126] The presentation of the programme led Achim Steiner, head of the UN Environment Programme to remark: "We cannot ask for more at this stage". *The Guardian*, 'China unveils climate change plan', 4 June 2007. Retrieved at http://www.guardian.co.uk/world/2007/jun/04/china.jonathanwatts.

[127] President Obama's address to joint session of Congress, 24 February, 2009. Retrieved at http://www.whitehouse.gov/the_press_office/Remarks-of-President-Barack-Obama-Address-to-Joint-Session-of-Congress/ on 30 March 2009.

[128] Reuters, 'U.S. praises China's climate efforts; urges more', 29 March 2009. Retrieved at http://www.reuters.com/article/latestCrisis/idUSLT67579 on 30 March 2009.

the Bali Conference of the Parties (COP-13) Mr. Su Wei, the Director-General of the Office of China's National Leading Group on Climate Change, stated the following:

> "On the one hand, the developed countries, whose long-time accumulative emissions of greenhouse gases are the main cause of climate change, should have the primary responsibility to cut their high greenhouse gas emissions (…). On the other hand, the developing countries, who are innocent in terms of responsibility for causing the problem, are by far the biggest victims."[129]

Even if emissions were to continue to increase, this balance will be slow to turn; Chinese emissions are estimated to be 16 percent of the cumulative total by 2030 under a business-as-usual scenario – still less than the projected share of the United States (25%) or the European Union (18%) by that time.[130]

China's per capita emissions levels are still very low compared with those of industrialised countries.

Currently, China's per capita CO_2 emissions stand at about 4 tonnes of CO_2 per capita, compared to 21 tonnes per capita in the United States and around 10 tonnes per capita in the European Union and Japan.[131] Even as China's per capita emissions have doubled since 1990, they are still far below the average of industrialised OECD countries and the United States in particular.

As a developing country, the key priority for China is economic development and poverty alleviation for its population.

Despite its economic growth of recent decades, Chinese per capita income levels are still only three-quarters of the world average and one-quarter of OECD levels, even if compared on purchasing power parity basis.[132] More than half of its population lives in rural areas, where income and welfare levels lag far behind the more affluent coastal areas. Given that the government's legitimacy derives from improving the living conditions of its population, economic development is prioritised above any action on climate change. As is stated in the *National Climate Change Programme*:

> "For developing countries with less historical emission and current low per capita emission, their priority is to achieve sustainable development. As a developing country, China will stick to its sustainable development strategy and take such measures as energy efficiency improvement, energy conservation, development of renewable energy, ecological preservation and construction, as well as large-scale tree planting and afforestation, to control its greenhouse gas emissions and make further contribution to the protection of the global climate system." (CNCCP, §5.1.1)

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[129] Wei, Su, Director-General of the Office of the National Leading Group on Climate Change, presentation on China's National Climate Change Programme, COP-13 Bali, 7 December 2007. Retrieved at http://www.ccchina.gov.cn/WebSite/CCChina/UpFile/File225.pdf on 15 Jan 2009.

[130] International Energy Agency, *World Energy Outlook 2007*, p. 199.

[131] International Energy Agency, *Key World Energy Statistic 2008*; United Nations Development Programme, *Human Development Report 2007/2008*.

[132] International Energy Agency, *Key World Energy Statistics 2008*.

A large share of China's industrial sector manufactures export products for industrialised countries. It is not fair for China to be held responsible for reducing the emissions from these industries.

In this argument put forward by China, it argues that – being the manufacturing base of the world – the emissions created by China's industry are in large part due to export articles produced for other countries. According to research by the British Tyndall Centre, exported goods correspond to roughly one-third of the total Chinese emissions and about one-quarter if adjusted for emissions embodied in imports.[133]

China is already doing the most it can do in combating climate change.

This point is being expounded by the entire public relations campaign surrounding *China's National Climate Change Programme*. The Chinese government claims that it has been very proactive in setting targets on reducing energy consumption and reducing its greenhouse gas emissions. Its target of reducing the energy intensity of its economy by 20 percent by 2010 is estimated to be equivalent to saving 1.5 billion tonnes of CO_2 emissions: almost five times the amount of emissions that are to be reduced by the European Union's EU-15 under the Kyoto Protocol.[134]

The Annex-I developed countries should take the lead before anything should be asked of less developed non-Annex-I countries. The targets agreed upon in Kyoto are not being met by many countries.

In response to pressure by developed countries to commit to stronger mitigation targets, the Chinese government has often retorted that the developed countries should lead the way first and that the record of Annex-I countries in following up on their Kyoto commitments has been rather disappointing. Many Annex-I countries will certainly not achieve their targets, and most of them only have a chance of achieving this by including carbon sinks in land use, land-use change (including forestry) and foreign emissions offsets. Russia and the Eastern European countries are well below their targets, but this has been only a side-effect of their economic collapse and emissions have been growing again in recent years. Canada gave up on its Kyoto target, while Australia followed the United States in refusing to ratify it – only changing its position in 2007 with the election of Prime Minister Kevin Rudd.[135] Japan is not making its target, which is especially worrying since it has always championed energy efficiency and energy conservation as one of the world's most energy import-dependent countries. Switzerland is not making

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[133] Wang, Tao and Watson, Jim, Tyndall Centre for Climate Change Research, 'Who Owns China's Carbon Emissions?', Tyndall Briefing Note No. 23, October 2007. Also: International Energy Agency, *World Energy Outlook 2008*, p. 387.

[134] This refers to the EU-15 member states that signed the Kyoto Protocol. Their base-year emissions have been set at 4265.5 Mt CO_2e. An 8 percent reduction would thus entail 341 Mt CO_2e. The EU-27 has no common Kyoto target, but adopted a 20 percent reduction goal for greenhouse gases compared to 1990. European Environment Agency, *Annual European Community GHG inventory 1990-2007 and inventory report 2009 – Executive Summary*, 2009, pp. 6,8,13.

[135] Despite more ambitions on climate change, Australia's proposed cap&trade bill did not pass the Senate in August 2009 in the first round. *IPS News*, 'Climate Change: Kyoto Gets a Slap in the Face from Canada', 9 December 2006. Retrieved at http://www.ipsnews.net/news.asp?idnews=35785 on 12 April 2009. BBC News, 'Rudd takes Australia inside Kyoto', 3 December 2007. Retrieved at http://news.bbc.co.uk/2/hi/asia-pacific/7124236.stm on 10 January 2009; *Bloomberg,* 'Australian Senate Rejects Rudd's Cap and Trade Emissions Plan', 13 August 2009. Retrieved at http://www.bloomberg.com/apps/news?pid=20601081&sid=aHo_TW08Y3to on 2 September 2009.

its target either.[136] The European Union is one of the few Annex-I parties that has fared better. The EU-15 member states that originally committed to an emissions reduction of 8 percent compared to 1990 achieved a reduction of 6.2 percent by 2008, and might still succeed in meeting the target without relying overly much upon carbon offsets.[137] Due to the inclusion of Eastern European states, the EU-27 is estimated to have achieved a reduction of 10.7 percent compared to 1990 in 2008.[138]

The current position of the United States is especially of interest. Compared to 1990 levels, greenhouse gas emissions increased by 14 percent in 2006.[139] Its intended goal under Kyoto, however, was to achieve a 7 percent reduction by 2012, reaching 1990 emissions levels around 2000. Now the *American Clean Energy and Security Act* (or *Waxman-Markey Bill*) that was passed in the U.S. House of Representatives on 26 June 2009, proposes to reduce American greenhouse gas emissions by 17 percent in 2020 compared to 2005.[140] Hence, if implemented, this would basically reverse the growth in emissions of the past two decades and approximately achieve 1990 emissions levels by 2020, leading the Chinese to argue that the United States effectively delayed their Kyoto commitments by 20 years.[141]

Hence, the Chinese negotiators argue that the commitments made in Kyoto have not been fulfilled for the large part and that the first obligation for all parties should be to implement those commitments to the full extent. As for China, as a developing country, it will do its part as well (which would consist of voluntary mitigation efforts):

> "*All parties are supposed to faithfully implement their respective commitments under the Convention and the Kyoto Protocol. The developed countries should fulfil their commitments of taking the lead to reduce their greenhouse gas emissions and providing financial assistance and technology transfer to the developing countries. As a country of responsibility, China will seriously fulfil its commitments under the Convention and the Kyoto Protocol.*" (CNCCP, §5.1.4)

Above-mentioned points have been the major pillars in China's argument that under the UNFCCC principle of "common but differentiated responsibilities", it should not in any way accept binding emissions reduction commitments, given its status as a developing country. This position has been reiterated by all Chinese officials in the lead-up to the

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[136] Change in emissions over 1990-2006 versus Kyoto targets: Australia +6.6% (Kyoto target +8%), Canada +54.8% (vs. -6%), Japan +5.8% (vs. -6%), Switzerland +1.5% (vs. -8%). These emissions are total greenhouse gas emissions including emissions/removals from land use, land-use change and foresty (LULUCF), and do not take into account emissions reductions which might be achieved by using the Kyoto flexible mechanisms. Excluding LULUCF, Australia stands at +28.8% and Canada at +21.7%. UNFCCC, *National greenhouse gas inventory data for the period 1990-2006 (FCCC/SBI/2008/12),* 17 November 2008.

[137] The original target should be achieved as an average (in annual emissions) over the five year period 2008-2012.

[138] However, if considering only CO_2 without LULUCF/emissions removals, emissions in the EU-15 actually increased from 3360 Mt CO_2 in 1990 to 3391 Mt CO_2 in 2007. European Environment Agency, *Annual European Community GHG inventory 1990-2007 and inventory report 2009 – Executive Summary*, 2009.

[139] According to the UNFCCC United States' emissions in 2006 compared to 1990 went up with 14 percent (total GHGs), for CO_2 the figure stands at +17.7%. This is including emissions/removals from land use, land-use change and forestry. Excluding these emissions/removals the figures are +14.4% for all GHGs and +18.1% for CO_2 emissions. UNFCCC, *National greenhouse gas inventory data for the period 1990-2006 (FCCC/SBI/2008/12),* 17 November 2008.

[140] And by 83% in 2050. For a detailed analysis of the bill see: Pew Center on Global Climate Change, 'The American Clean Energy and Security Act (Waxman-Markey Bill)'. Retrieved at http://www.pewclimate.org/acesa.

[141] *Xinhua News,* 'Developed countries need to show will at climate talks', 9 June 2009. Retrieved at http://www.chinadaily.com.cn/world/2009green/2009-06/09/content_8264093.htm on 12 June 2009.

Copenhagen conference, most prominently by Premier Wen Jiabao during his visit to Europe in January and February 2009.[142]

3.3 Submitted proposal to the UNFCCC

In the current negotiation process for a post-Kyoto treaty, the Chinese delegation submitted the proposal that all developed countries should reduce their greenhouse gas emissions by at least 25 to 40 percent below 1990 levels in 2020 and by approximately 80-95% in 2050. For developing countries mitigation actions should be "nationally appropriate" and taken "in the context of their sustainable development and, supported and enabled by technology transfer, financial assistance and capacity building to be provided by the developed country Parties." In a specific response to the idea of achieving greenhouse gas reduction commitments through global sectoral agreements, China flatly refuses to participate, stating: "The aim of cooperative sectoral approaches and sector-specific actions is (…) promoting development, deployment, diffusion and transfer of greenhouse gas emissions control technologies, practices and processes. Any twist of this understanding or discussion under the AWG-LCA leading to global sectoral

People's Republic of China – submitted proposal to the UNFCCC	
Intermediate goal	For Annex-I Parties: 25-40% reductions below 1990 levels in 2020. For non-Annex-I Parties: nationally appropriate mitigation actions in the context of their sustainable development.
Long-term goal	For Annex-I Parties: 80-95% reduction in 2050. For non-Annex-I Parties: no specific targets.
Mitigation	Annex-I country Parties should commit to fixed reduction targets.
Adaptation	Preparation of National Adaptations Programmes of Action and the establishment of an Adaptation Fund.
Technology transfer	Establishment of a Multilateral Technology Acquisition Fund; promotion of the development, transfer and deployment of environmentally sound technologies.
Financing	Annex-I Parties should provide 0.5-1% of their annual GNP in addition to existing official development assistance.

Table 3.1 China's submitted proposal to the UNFCCC. Released prior to the COP-14 in Poznan, under the title , *"China's Views on Enabling the Full, Effective and Sustained Implementation of the Convention Through Long-Term Cooperative Action Now, Up To and Beyond 2012",* 28 September 2008.

[142] *Financial Times*, interview with Premier Wen Jiabao, 2 February 2009; Tu, Jianjun, 'Future prospects of China's Policy on Climate Change', Jamestown Foundation *China Brief*, Vol. IX Issue 1, 12 Jan 2009, p. 13.

standards, benchmarks or emission reduction targets is not acceptable."[143]

Concerning adaptation, China has been arguing for more emphasis on this issue, stressing that for developing countries adaptation is a more present and imminent task in comparison to the long and arduous challenge of mitigation and deceleration of climate change. It calls for the preparation of National Adaptation Programmes of Action by all developing countries and an Adaptation Fund where Annex-I Parties can contribute financial resources. Furthermore, China advocates the establishment of a Multilateral Technology Acquisition Fund in order to promote the development, transfer and deployment of environmentally sound technologies. According to China, the financial resources provided by Annex-I developed country Parties should be 0.5-1% of their annual GNP in addition to existing official development assistance (see Table 3.1).

In a statement issued by the National Development and Reform Commission on 20 May 2009, the Chinese actually sharpened their demand, arguing for the maximum cut of 40 percent by 2020 compared to 1990 emissions levels by developed countries.[144]

3.4 Domestic drivers for a changing stance

Even though the official line on the climate treaty negotiations has been quite unrelenting, there is a debate going on in Chinese society on climate change and what China's position should be in it. Among the discussions are some trends that might contribute to softening the government's stance.

Increasing awareness of the impact of climate change on China

Scientific research by Chinese as well as international scholars has called attention to the very serious consequences that global warming are expected to have on China. Among the most important effects are desertification, reduced water resources and an increase of 'extreme weather events' such as droughts, floods and typhoons. The impact of typhoons and floods is directed mostly at the south and middle parts of China, which are densely populated. The northern regions are more vulnerable to droughts and desertification, which are already very serious problems in China. The shrinking of the Himalayan glaciers which feed the most important rivers in China, such as the Yangtze and Yellow River, is aggravating the scarcity of water resources and could have a dramatic effect on food production. According to some reports, agricultural output of three of the country's four major grain crops might drop by 37 percent by 2050 due to the effects of climate change, posing an enormous challenge to China's food security.[145] Finally, a significant rise in sea level could affect millions of people in the many cities along the densely populated coastline. Gradually awareness of these potential effects is

[143] UNFCCC, 'China's Views on Enabling the Full, Effective and Sustained Implementation of the Convention Through Long-Term Cooperative Action Now, Up To and Beyond 2012' [China's submission before the COP-14 in Poznan], 28 September 2008. Retrieved at http://unfccc.int/files/kyoto_protocol/application/pdf/china_bap_280908.pdf on 15 Jan 2009.

[144] National Development and Reform Commission, 'Implementation of the Bali Roadmap: China's Position on the Copenhagen Climate Change Conference', 20 May 2009.

[145] Economy, Elizabeth (Council on Foreign Relations), Testimony before the U.S. Senate Foreign Relations Committee, Hearing on "Challenges and Opportunities for U.S.-China Cooperation on Climate Change", 4 June, 2009.

increasing in China, both among the general public as in government circles, although in general it is not yet regarded with sufficient urgency to act on these threats.[146]

Increasing environmental concerns

As have many other developing countries before it, China has in many cases sacrificed the environment to achieve economic development. The overriding priority given to economic growth has led to increased desertification, acid rain, soil erosion, water shortages, dispersal of toxic waste, declining quality of drinking water and air pollution, to name but a few of the more conspicuous consequences. Total costs of environmental damage are estimated to be around 8 to 13 percent of the Chinese GDP. In particular, the problem of air pollution has become extremely serious: one-third of urban citizens in China breathe heavily polluted air, and 20 of the world's 30 most polluted cities in terms of air quality are located in China.[147] For a large part this problem can be attributed to the dominant position of coal in China's fuel mix, and this makes reducing air pollution an significant driver to reduce China's coal dependency.

A positive development in this respect is that the Chinese public is slowly becoming more vocal on the environmental front. In a well-publicised incident, large scale protests in Xiamen prevented the construction of a chemical factory there in 2007: a quite remarkable feat illustrating the growing impact of environmental movements in China.[148] Also in political circles attention for the environment is slowly but steadily gaining ground: a key figure championing the environmental cause is the Vice Minister of the Ministry of Environmental Protection, Mr. Pan Yue. He has promoted the concept of measuring the so-called 'Green GDP' in China, taking environmental developments into consideration apart from the conventional economic indicators. Mr Pan has been one of the most outspoken high officials arguing that the current development trajectory of China is unsustainable and will need to be changed.

Long term sustainability concerns and the need for a sustainable energy supply

To secure its demand for energy is one of the most critical challenges facing China in the course of its rapid development. While China's rising dependency on oil imports is the first and most urgent threat in terms of energy security, with upcoming significant gas imports being the next, a more fundamental problem underlies this issue.

If one takes a broader perspective, the looming threat facing China is simply that the country's increasing levels of energy consumption cannot be sustained in the long term. This is not only because of the related impact on climate and environment, but also simply because global fossil fuel reserves and production ratios are not sufficient: not only is demand outstripping China's domestic supplies, but it also cannot be accommodated by the global energy markets in the long run. While East-Asian

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[146] Gørild Heggelund, "China's Climate Change Policy: Domestic and International Developments", Asian Perspective Vol. 31, No. 2, 2007, p. 167.

[147] International Energy Agency, *World Energy Outlook 2007*, p. 252. Pan, Yue, 'Green China and young China (part one)', *Chinadialogue.net*, 17 July 2007.

[148] *Xinhua News*, 'Chemical plant to be relocated after public protest', 8 March 2008; He, Gang, 'China's New Ministry of Environmental Protection Begins to Bark, but Still Lacks in Bite', EarthTrends / World Resource Institute, 17 July 2008.

neighbours like Japan and South Korea have successfully followed a developmental path lifting their per capita income and energy consumption levels to OECD standards, this trajectory will be impossible to follow by China unless it also makes a major transition in its energy system.

Some simple calculations illustrate this point: suppose per capita oil consumption in China would reach the same level as in the United States, it would need about 90 million barrels per day, slightly more than the current global production. Add India at U.S. consumption levels, and the total would become almost 170 million barrels per day – about double the current production of crude oil worldwide.[149]

The Chinese leadership is aware of this challenge, and this has led to the renewed focus on energy efficiency and conservation in China's energy policy and the promotion of alternative energy sources: in short, the same measures which resurface in its action programme on climate change.[150] It illustrates that to a large extent, a sustainable energy system also corresponds with a low-carbon energy system. Chinese think-tanks and prestigious scientific institutes, too, have insisted on the necessity of transforming China's energy system. In its report *Addressing the Challenge: Developing a Sustainable Energy System* the Chinese Academy of Sciences has argued for very ambitious goals limiting the dependency on fossil fuels in order to "ensure the achievement of stable transition from the current fossil fuel-based energy system to a sustainable energy system".[151]

More ambitious commitments under the UNFCCC framework by China will not only address the issue of global climate change, but will also prepare China for a more sustainable future of energy consumption. The crucial point is that the world needs China to make haste in this process, more haste than it is making at the moment. Still, the self-interest of China is also served by a transition to a long term sustainable energy system which is enhancing the prospects of successful negotiations in Copenhagen.

3.5 Possible ways to deal with China at Copenhagen

Given the rather uncompromising stance of China in the run-up to the climate treaty negotiations in Copenhagen, one might wonder how there can be any chance of reaching a possible deal in which China would be involved. There are some signals however, that suggest that China is willing to discuss and compromise on its official stance, yielding possibilities for reaching an agreement.

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[149] For 2006, per capita oil consumption in China stood at 0.006 barrels per day per capita; Germany and the United States stood at 0.029 and 0.069 barrels per day per capita, respectively. Data from: *BP Statistical Review of World Energy 2008* and International Energy Agency, *Key World Energy Statistics 2008,* pp. 48-57. Also see 'Can China and India Ever Mirror Western Lifestyles?' in: IEA, *World Energy Outlook 2007*, p. 215.

[150] Jiang, Zemin [江泽民] (President of the People's Republic of China from 1993 until 2003), 'Reflections on Energy Issues in China' [对中国能源问题的思考], Journal of Shanghai Jiaotong University, vol. 13 no. 3, 2008, pp. 257-274.

[151] Chinese Academy of Sciences, news item 'Jointly addressing the challenge: Developing a sustainable energy system', 22 October 2007, retrieved at http://english.cas.ac.cn/eng2003/news/DetailNewsb.asp?InfoNo=26814 on 20 April 2009. Announcing the release of the report: Chinese Academy of Sciences, *Addressing the Challenge: Developing a Sustainable Energy System* [Chinese title: 应对挑战—构建可持续能源体系], October 2007. Specific recommendations included: limiting the increase in fossil fuel consumption from 2005 to 2050 to a maximum of 50 percent; increasing the proportion of hydropower and nuclear power to more than 20 percent of the total electricity generating capacity and raising the share of non-hydro renewables to 25 percent of the total energy consumption.

The domestic debate on Chinese emissions trajectories

Although not in line with China's official negotiating standpoint, some scientists and officials have started to speak out on the need for China to start curbing its emissions. One conspicuous example is the top economist Hu Angang, who is also advising Premier Wen Jiabao on economic and environmental policy. In a controversial essay he has argued for cutting overall emissions from 2020 onwards, reducing Chinese emissions to 1990 levels by 2030 and to half of 1990 levels by 2050.[152] With respect to suitable targets he has argued for substituting the Annex-I / non-Annex-I division by a system of four categories based on the U.N. Human Development Index, with gradually increasing commitments. This publication has received quite some attention in the West, but it should be kept in mind that this is one of the more extreme proposals that has surfaced and does not represent the view of the Chinese government.

However, several research institutes closely involved in Chinese policy making have also published results related to Chinese emission scenarios. A report entitled "China's Energy Demand and CO_2 Emissions Scenarios for 2050" with climate policy experts from leading think-tanks such as the Energy Research Institute and the State Council's Development Research Centre, outlined three possible scenarios leading up to 2050.[153] The business-as-usual projection shows emissions levelling off in 2040 after having doubled from current levels. The "Low Carbon" scenario envisages emissions reaching a plateau already in 2020 and keeping more or less steady up to 2050. In the most ambitious "Enhanced Low Carbon" scenario, the report proposes that it might be possible for Chinese emissions to slow after 2020, peaking in 2030 and returning to 2005 levels by 2050.[154] Another analysis put forward in the *China Sustainable Development Strategy Report 2009* issued by the Chinese Academy of Sciences, suggests that it would be feasible for China to peak emissions between 2030 and 2040.[155]

Although these proposals and scenarios are far ahead of official government policy, there have been signs that also in official circles more discussion is possible about issues such as the peaking of Chinese emissions. Mr. Su Wei, one of the key officials on climate change has stated that Chinese emissions will not continue to grow after 2050, while the lead negotiator Mr. Yu Qingtai has mentioned that he would like to see Chinese

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[152] Hu, Angang, 'A new approach to Copenhagen' (1/2), *Chinadialogue.net*, 6 April 2009; *The Guardian,* 'China considers setting targets for carbon emissions', 19 April 2009. Retrieved at http://www.guardian.co.uk/world/2009/apr/19/china-environment-kyoto on 20 April 2009.

[153] *Reuters,* 'China study urges greenhouse gas caps, peak in 2030', 17 August 2009. Retrieved at http://www.reuters.com/article/latestCrisis/idUSSP434277 on 24 August 2009. The Chinese title of the report is中国2050年的能源需求与CO2排放情景. Leading authors are 姜克隽(Ke-Jun Jiang);胡秀莲(Xiu-Lian Hu);庄幸(Xing Zhuang);刘强(Qiang Liu);朱松丽(Song-Li Zhu). For information on the report see: http://www.ceps.com.tw/ec/ecjnlarticleView.aspx?jnlcattype=0&jnlptype=0&jnltype=0&jnliid=2731&issueiid=731488&atliid=1316601.

[154] *China Environmental Law,* '"Low" Carbon?', 18 August 2009. Retrieved at http://www.chinaenvironmentallaw.com/2009/08/18/low-carbon/ on 24 August 2009.

[155] Chinese Academy of Sciences, *China Sustainable Development Strategy Report 2009*, 2009. Discussed at: *The Climate Group,* 'New CAS Report: Positive Outlook for China's Low Carbon Development', 2 March 2009. Retrieved at http://www.theclimategroup.org/news_and_events/cas_sustainable_development_strategy_report/ on 26 August 2009. The report also mentions that energy intensity of GDP could be lowered by 40 to 60 percent by 2020 compared to 2005, thereby reducing the CO_2 emission intensity of GDP by about 50 percent.

emissions peak as soon as possible.[156] There are also suggestions that China might include more climate change specific policy in their 12th Five Year Plan (2011-2015) which is being drafted. One of the measures under consideration is setting a carbon intensity target, which will be discussed below.[157] Another concept that has been investigated by the Ministry of Finance is the option to instigate a carbon tax (together with an energy tax and an environment tax) in order to stimulate sustainable development.[158] Even though the official stance has not been adjusted, these developments warrant some optimism and show China is taking a constructive approach to the climate treaty negotiations.[159]

Choosing a suitable target: a role for emission intensity targets?

The United States, the European Union and most other developed countries have called for commitments by developing countries to start limiting the *growth* of their emissions, acknowledging that it will be too early to demand absolute emissions reductions. The European Union, for instance, has demanded that "economically more advanced developing countries make a contribution commensurate with their respective responsibilities and capabilities", as a condition for extending its own reduction target for 2020 from 20 percent to 30 percent (compared to 1990 levels). More specifically, the E.U. Commissioner for Environment Stavros Dimas has argued that developing countries should keep their emissions 15 to 30 percent below business-as-usual levels in 2020.[160]

The catch with this requirement is establishing the business-as-usual scenario. As the discussion in Chapter 1 on China's explosive growth of emissions has shown, it will be extremely difficult to establish a reliable business-as-usual scenario for China. The forecast for China's emissions in 2030 by the International Energy Agency has been raised by 70 percent in just 5 years' time, and the Chinese observers did not fare much better in projecting their own emissions growth.[161]

A solution might be to focus on emission intensity. The Chinese government has already implemented a binding energy intensity target in its own most recent Five Year Plan. Under this plan, the energy intensity of the economy, i.e. the amount of energy consumed to produce one unit of gross domestic product, should fall with 20 percent in a period of 5 years. Given the link between energy consumption and carbon dioxide emissions, this target could be easily transformed into an *emission intensity* target, which would indicate the level of emissions associated with one unit of gross domestic product.

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[156] *Financial Times,* 'China sets date for CO2 cut', 15 August 2009. Retrieved at http://www.ft.com/cms/s/0/cfc5d2fa-8933-11de-b50f-00144feabdc0.html?nclick_check=1 on 24 August 2009.

[157] *Reuters,* 'China signals long-term plans to curb greenhouse gases', 13 August 2009. Retrieved on 24 August 2009 at http://www.reuters.com/article/environmentNews/idUSTRE57C05L20090813?pageNumber=1&virtualBrandChannel=0,

[158] Mentioned by Mr. Su Ming, Deputy Director of the Institute of Financial Science in the Ministry of Finance at the 2009 High-Level Forum on Sustainable Development of China's Energy Resources. *China.org.cn*, 'Government 'to impose Carbon Tax', says official', 22 April, 2009. Retrieved on 27 August 2009 at http://www.china.org.cn/environment/policies_announcements/2009-04/22/content_17652059.htm.

[159] Wong, J.L., 'Peaking Duck: Beijing's Growing Appetite for Climate Change', *Center for American Progress*, 20 August 2009. Retrieved at http://www.americanprogress.org/issues/2009/08/peaking_duck.html on 26 August 2009.

[160] *COP-15 News Item*, 'EU: OECD-wide carbon credit market by 2015', 7 April 2009. Retrieved at http://en.cop15.dk/news/view+news?newsid=1050 on 6 May 2009.

[161] Levine, Mark D. and Aden, N. T., *Global Carbon Emissions in the Coming Decades: The Case of China*, 2008, pp. 15-17.

Mr. Su Wei, Director-General of China's National Leading Group on Climate Change and one of China's top officials on climate change, reflected on this idea as follows:

> "It is an option. We can very easily translate our [existing] energy reduction targets to carbon dioxide limitation. (…) China hasn't reached the stage where we can reduce overall emissions, but we can reduce energy intensity and carbon intensity".[162]

Such a target could be chosen to entail a significant mitigation effort, while not limiting economic growth China in any manner. Moreover, it would be a measurable indicator and would circumvent the difficulty of forecasting the economic development and emissions growth of China, which would be necessary for establishing a business-as-usual scenario as a reference for mitigation achievements.

A role for sectoral agreements?

Another option for setting targets and stimulating the reduction of greenhouse gases while at the same time trying to maintain a level playing field are so-called *sectoral approaches*, in which some kind of target on emissions reductions for a specific sector is set internationally, industry-wide. Even though the Chinese strongly object to this idea, the virtue of such agreements is that they would address concerns about distorted competitiveness in the world economy due to climate change measures and reduce the risk of carbon leakage, i.e. the migrating of companies to countries with less strict emissions regulation.[163] The sharing of best practices and technology in each sector could be employed in order to achieve emissions reduction targets.

The concept of sectoral approaches is thought to work especially well with industries that are both energy-intensive and have a limited number of global players, such as the steel, cement, aluminium, automobile and aviation sectors.[164] In almost all of these sectors China is a major player or set to become one. This ensures the significant impact of sectoral agreements which would include China.

Use carrots, not sticks…

In some developed countries and particularly in the United States, dissatisfaction is voiced in response to China's uncompromising stance in the climate change discussions, and fears of losing economic competitiveness under a possible climate change regime are quite strong. Some argue for forcing China to make a commitment at Copenhagen by applying various means of pressure, mostly through trade restrictions.

In general it can be said that the idea of forcing China into some kind of agreement by applying some kind of political force is a rather risky one. Even though China is not a democracy, the Chinese government is still very much concerned about its public image and will certainly not like to 'lose face' in these negotiations. On the other hand, convincing China to join a global scheme on climate change and earn acclaim as a 'deal-

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[162] *The Guardian,* 'China considers setting targets for carbon emissions', 19 April 2009. Retrieved at http://www.guardian.co.uk/world/2009/apr/19/china-environment-kyoto on 20 April 2009.

[163] International Energy Agency, *World Energy Outlook 2008*, pp. 427-434.

[164] For an analysis of possible sectoral agreements in the steel sector, see: Clingendael International Energy Programme, *The Climate for Steel*, Clingendael Energy Paper, 2009.

maker' would give it a much bigger incentive, as it would match exactly in its aspiration to be regarded as a responsible stakeholder in the global political system.

Yet there is still a huge potential for conflict between the United States and China in this respect, despite all the efforts to forge cooperation on energy and climate change under the new Obama administration. One of the key obstacles is that the domestic legislation in the United States is lagging behind, hampering its ability at Copenhagen to put pressure on other parties to take strong action. Second, the economic crisis and fear of further job losses makes the United States very much concerned about creating a level playing field and avoiding loss of economic competitiveness. In fact, the *American Clean Energy and Security Act* leaves open the possibility of instigating a carbon border tax on imports originating from countries that do not adhere to sufficiently strict emissions reduction targets: an addition which seems to have been written with China in mind. It goes without saying, that it would be a serious blow for global trade if the international climate change regime would develop in this direction.[165]

On the 'carrot' side, there is the main question of extending technology transfer and funding for mitigation and adaptation. Decisions on the implementation of an Adaptation Fund has been one of the few achievements of the Bali conference, although there have been very little contributions made to date. Almost all of the Annex-I countries are saving their financial contribution commitments for the bargaining process at Copenhagen. Concerning climate-related technology transfer, India has argued on behalf of the developing world that a special system should be created to address patents and intellectual property rights in order to ensure the most rapid deployment of low-carbon technology. This topic and the expansion of the Clean Development Mechanism are of key importance to get China involved and create enough benefits for the Chinese to commit to any targets.

[165] Lee, Bernice and Mabey, Nick, 'An EU-China pact is key to a global climate deal', *Europe's World*, Autumn 2008. Commentary on U.S. protectionism by Jim Watson and Tao Wang.

4

Chances and impediments: focal points

The discussion on the climate treaty negotiations largely revolves around the possible participation of China through some target aimed at reducing its emissions. Yet it has also been widely acknowledged that China has already embarked on an ambitious programme in order to put its energy system on a more sustainable footing and bring down its energy consumption and greenhouse gas emissions.

This chapter will present an analysis of the primary obstacles and opportunities related to climate change mitigation in China. Crucial for any intensified effort by China is to know what can be realistically demanded given China's domestic situation. For this, it is necessary to assess the current effort and the potential for further action. The first section in this chapter will analyse of the impact of government policies, while the second section will focus on the critical issue of dealing with coal in China. As long as this most carbon-intensive fossil fuel will continue to dominate China's energy mix the prospects for global climate change mitigation are dim. Third, we will discuss the need for reform and for strengthening authority on energy and climate: an essential step towards the successful implementation of policy aimed at sustainable development. The last two sections deal with the role of China as an economic competitor, especially in the field of low carbon energy technologies, and the impact of the financial and economic crisis.

4.1 What is the impact of current policy?

We have seen that China has taken many positive initiatives in order to limit emissions growth and to contribute to fulfilling its important role in global mitigation schemes. In particular, the developments in energy efficiency and alternatives to coal such as hydropower, wind power and nuclear energy have been impressive, with targets often being exceeded or revised upwards. So where does this bring us?

First of all, the 20 percent reduction target of energy intensity is estimated to be comparable to annual emissions savings of about 1.5 billion tonnes of CO_2 by 2010.[166] This amount is almost five times the CO_2 reduction targeted by the European Union's EU-15 member states under the Kyoto Protocol.

[166] Lin, J., Zhou, N., Levine, M. and Fridley, D., 'Taking out 1 billion tons of CO_2: The magic of China's 11th Five-Year Plan?', *Energy Policy*, vol. 36, 2008, p. 954.

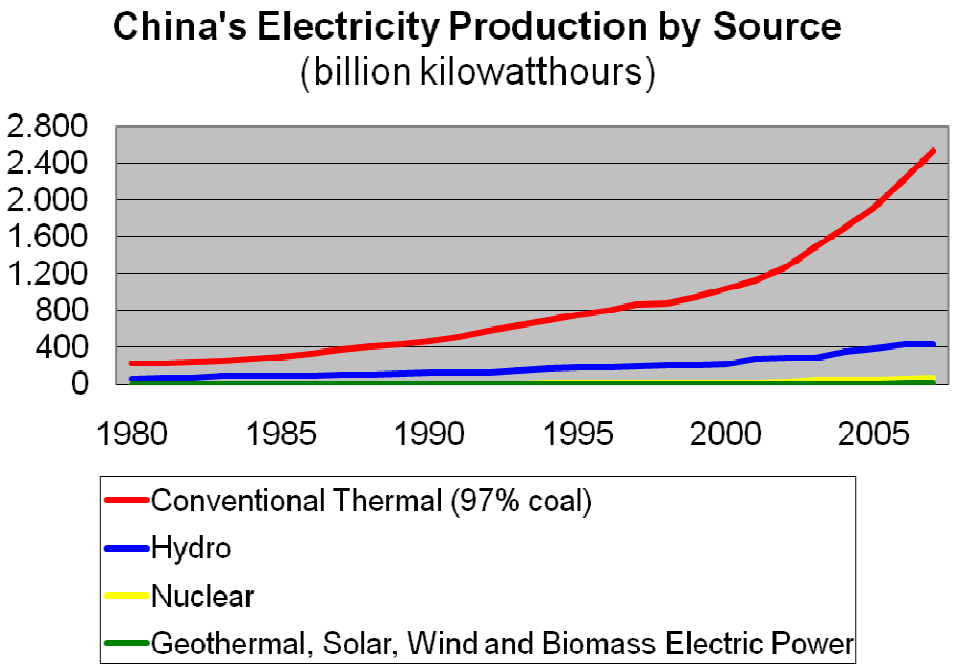

Table 4.1 Development of Chinese electricity production by source 1980-2007. Source: Energy Information Agency, U.S. Department of Energy, *International Energy Data, Net Electric Power Generation*. Most Recent Annual Estimates, 2008.

Other initiatives, such as the development of renewable energy and nuclear power are mostly aimed at substituting coal in the power sector. If we look at the trend in generating capacity in the past years in Table 4.1, we see that coal-fired generation is still growing at a rapid speed and that nuclear, hydro and other renewable are still not making a big impact. To assess if this will change it might be instructive to have a look at where the plans of the government might take us.

If we focus on 2020 and assume current policy targets will be met by then, filling in the details with projections from the International Energy Agency, we arrive at the following picture: see Table 4.2. In this hypothetical scenario, renewables and nuclear energy account for 42 percent of the power generating capacity and the share of coal drops from 72 to 58 percent. Due to the intermittent output of renewable energy the share of coal in actual generated electricity will be a bit higher and might be close to 70 percent.

The major problem with assessing the impact of the growth of renewables and nuclear energy on displacing coal is being able to make an accurate projection of the expected *total* capacity. Sectors such as wind and nuclear energy have outperformed their targets, leading to significant upward revisions of those targets. However, the impact is limited because the *overall* growth of the power sector is exceeding expectations. This still hinders a significant increase of their share in the energy and power fuel mix above projections.

Energy type	Capacity (2006)[x]	Shares	Capacity (2020)	Shares
Hydro	132	21%	300	21 %
Wind	3	0%	100	7 %
Gas	14	2%	70	5 %
Nuclear	7	1%	70	5 %
Biomass	2	0%	30	2 %
Oil	16	3%	20[x]	1.4%
Solar	0	0%	10	0.7%
Total non-coal	***174***	***2 %***	***600***	***42%***
Coal	449	72%	818	58%
Total capacity	622	100%	1418[x]	100%

Table 4.2 Overview of power generation capacity by 2020, under the assumption that current policy objectives will be achieved. Source: various government targets, additional projections (marked by [x]) taken from the Reference Scenario in International Energy Agency, *World Energy Outlook 2008*, p. 531.

In 2006, the government had set the overall power capacity target for 2020 at 1000 GW, but after having grown from 623 GW in 2006 to circa 800 GW in 2008, the government is considering raising the 2020 target to 1400-1500 GW.[167] The International Energy Agency projects a capacity of 1418 GW for 2020, yet previous estimates have often proven to be too conservative. For instance, the IEA estimates an electricity demand growth rate of 4.7 percent on average in the period 2006-2030, but this rate has stood at more than 9 percent since 2000 (and more than 13 percent in the years 2003-2006). The financial and economic crisis caused a drop in electricity demand in the beginning of 2009, yet this is considered to be but a temporary respite.[168] Although one can be quite sure that the high growth rates of previous years will decrease in the coming decades, there is still a significant risk that electricity consumption will exceed current projections.

To compare the current effort with what is deemed possible, we shall briefly analyse two scenarios that have been developed on China's future energy use and emissions trajectory.[169]

[167] *China Daily*, 'China may soon revise power goal', 2 July 2009. Retrieved at http://www2.chinadaily.com.cn/bizchina/2009-06/02/content_7962785.htm on 6 July 2009.

[168] *China Daily*, 'China's power consumption down 4.03% in 1st four months', 1 June 2009. Retrieved at http://www2.chinadaily.com.cn/china/2009-06/01/content_7960363.htm on 6 July 2009.

[169] Of course, there are many more studies focusing on China's future emissions and its mitigation potential. Some worth mentioning are: Wuppertal Institute/Ecofys, *Proposals for contributions of emerging economies to the climate regime under the UNFCCC post 2012*, June 2008; Wang, Tao and Watson, Jim, *Carbon Emissions Scenarios for China to 2100*, Tyndall Centre, September 2008. On the impact of RES: Urban, F., 'Sustainable energy for developing countries. Modelling transitions to renewable and clean energy in rapidly developing countries', PhD thesis at the Rijksuniversiteit Groningen, the Netherlands, 2009.

McKinsey – China's Green Revolution (2009)

This McKinsey study on China's emissions abatement potential reckons that with the vigorous introduction of renewables, nuclear energy and CCS, the share of coal in China's power supply could be as low as 34 percent by 2030. This would cut emissions from China's power sector by 3.8 Gt CO_2e, a drop of 70 percent compared to the study's baseline scenario. Together with savings in emission intensive industries (2.1 Gt CO_2e), buildings & appliances (1.6 Gt CO_2e), road transportation (0.6 Gt CO_2e) and some other areas, the total of China's emissions in 2030 could be lowered by 6.7 Gt CO_2e from an estimated baseline of 14.5 Gt CO_2e to 7.8 Gt CO_2e: a reduction of 46 percent compared to business-as-usual. This would come at the incremental cost of 150-200 billion euros per year over the period 2010-2030, on top of the baseline investment figures. Approximately one-third of these investments are expected to have positive economic returns, one-third will have slight to moderate economic cost, and the final one-third will have substantial economic costs associated with them.[170]

International Energy Agency – Alternative Policy Scenario for China (2007)

In its Alternative Policy Scenario for China in the *World Energy Outlook 2007*, the International Energy Agency estimates that China can save up to 15 percent of its projected energy consumption by 2030. This saving is comparable to Africa's entire energy consumption in 2005, but nonetheless demand would increase by about 90 percent between 2005 and 2030. The main instrument for achieving the energy savings would be stricter enforcement of current government policies, closing down small and inefficient plants and introducing modern highly efficient technologies. Structural changes in the economy towards a more service-oriented model contribute significantly as well, accounting for more than 40 percent of the total energy savings. In the scenario, coal demand would be reduced by 23 percent: close to 40% of the savings would come from reduced electricity demand (mainly in the industrial sector), while 30% would be contributed by improved power-generation efficiency. The result for CO_2 emissions would be a reduction of 2.6 Gt of CO_2 by 2030, about 22.5% compared to the Reference Scenario.[171] Emissions savings would be achieved by increased fuel economy in vehicles, stricter building codes and structural change in the economy (41%), more efficient motor systems and more efficient appliances (28%), increased use of renewables in power generation and alternative fuels in transport (17%), switching from coal to gas and improved coal-fired generation efficiency (8%) and increased use of nuclear energy (6%). The energy efficiency improvements would contribute mostly via emissions savings in the power sector, where emissions are 1.5 Gt lower than in the Reference Scenario (57% of the total savings). Coal-fired plants would still supply 64 percent of all electricity in 2030, but hydro, wind and solar PV would need to exceed the government targets earlier than that, by 2020. Overall, China's energy-related CO_2 emissions would stabilise soon after 2020 at around 9 Gt CO_2/year.[172]

[170] McKinsey & Company, *China's Green Revolution*, 2009, pp. 9-11.

[171] Reference Scenario energy-related CO_2 emissions for 2030: 11.45 Gt CO_2/year. Alt. Policy: 8.88 Gt CO_2/year.

[172] Chapter 11 in: International Energy Agency, *World Energy Outlook 2007*, pp. 361-388.

Evaluation of China's current policies

If everything goes according to plan, the policies and targets in place will significantly reduce China's dependency on coal. However, the crucial factor for success is controlling the growth of electricity demand. Recent experiences have shown that this demand could very easily outpace all projections, negating the positive impact of current policies.

Both scenarios confirm that the potential for emissions mitigation in China is huge. The current policies are a good first step but will need to be followed up by strong enforcement in order to achieve the maximum potential of greenhouse gas abatement. The two scenarios show us that with more vigorous policy and implementation efforts, even larger gains can be made in climate change mitigation. This could possibly lead to a peaking of Chinese emissions soon after 2020 (according to the IEA scenario) and a reduction of the share of coal in China's power supply to 34 percent by 2030 (according to McKinsey). However, as the McKinsey study indicates, there will be considerable costs associated with this, especially with implementing measures like introducing carbon capture and storage (CCS) in China on a large scale before 2030.

4.2 The need for dealing with coal in China

China's energy system is dominated by coal, which is responsible for three-quarters of its total carbon dioxide emissions. As a consequence, the key to influencing China's future emissions lies in dealing with China's coal consumption. The wish to diversify its energy consumption pattern, infrastructural problems related to coal supply, and environmental considerations related to air pollution and acid rain have together led China to issue policy trying to limit its use of coal. However, the abundant reserves and the cheap cost of coal are impeding the progress on this objective. Coal consumption has increased dramatically in recent decades, almost doubling from 899 million tonnes of oil equivalent (mtoe) in 2000 to 1734 mtoe in 2006. As China is both the world's largest coal producer and coal consumer, accounting for more than 40 percent of global coal demand, this has had global repercussions, making coal the fastest growing fossil fuel for the past six years.[173] It accounted for two-thirds of the global demand growth for coal between 2000 and 2006 and thus contributed significantly to the trend of global energy consumption steadily becoming *more* carbon-intensive, instead of moving towards a low-carbon system.[174]

Current energy policy with respect to coal

China has indicated that it wishes to reduce the share of coal in its total energy consumption, currently standing at circa 70 percent, yet it is not pushing the limits to achieve this reduction. While the *National Energy Policy and Strategy* report suggested reducing the share of coal in the fuel mix to 60 percent by 2020, this has not been taken up in official policy, and the energy white paper only mentions the goals of "developing the coal industry in an orderly way" and push forward "clean coal-fired electric power". [175] This rather cautious strategy reflects the difficulty that China has

[173] British Petrol, *Statistical Review of World Energy*, June 2009, p. 5.

[174] International Energy Agency, *World Energy Outlook 2008*, pp. 123-127.

[175] State Council, *China's Energy Conditions and Policies* (White Paper on Energy), December 2007, section IV.

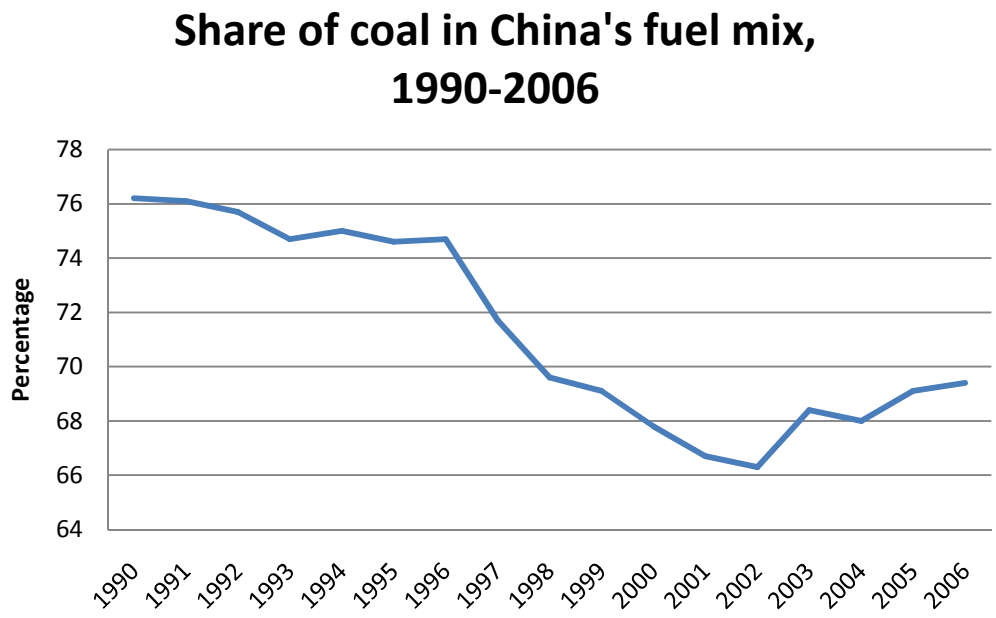

Table 4.4 Share of coal in China's fuel mix, 1990-2006.
Source: National Bureau of Statistics, *China Statistical Yearbook,* 2008. Percentage of coal in total energy consumption.

encountered in trying to reduce its dependency on coal. While the share of coal has been brought back from the high level of about 76 percent that it had in the early 1990s – an achievement much heralded by both the energy white paper and China's action plan on climate change – the percentage has gone up again in recent years after hitting a low of 66 percent in 2002 (see Table 4.4). Currently, the National Development and Research Commission has targeted a share of 66.1 percent for coal in the fuel mix by 2010 in its 11th Five-Year Plan.[176]

The means by which China is trying to limit its reliance on coal fall into two categories: demand-side reduction through energy efficiency and conservation measures; and the substitution of coal by other energy resources, such as nuclear energy, natural gas and renewable energy sources. While the promotion of energy efficiency, nuclear energy and renewables has already been discussed in Chapter 2, we will now briefly discuss the potential role of natural gas as a cleaner alternative to coal, the deployment of advanced technologies in order to make more efficient use of coal, coal-to-liquid developments and finally the prospect of carbon capture and storage in order to mitigate the impact of coal consumption in China.

[176] APERC, *APEC Energy Overview 2007*, January 2008, p. 52.

Fuel switching to natural gas: an important option for mitigation?

Natural gas has been touted as an important substitute fuel for replacing coal in China's fuel mix and limiting greenhouse gas emissions. Carbon dioxide emissions from natural gas combustion are only 57 percent of that of coal, making it a key fuel to mitigate climate change.[177] Up until now, natural gas has had only a marginal role in China's fuel mix, accounting for only 3 percent of its total energy consumption, although both demand and consumption have been growing at rapid rates. Reasonably successful exploration activities have increased the amount of proven gas reserves in China, which were revised upward from 1.37 trillion cubic metres (tcm) at the end of 1998 to 2.46 tcm at the end of 2008. Domestic production more than doubled from 35 bcm in 2003 to 76 bcm in 2008.[178]

The successful development of natural gas led the government to issue ambitious targets for the promotion of natural gas in China's energy system, setting the goal for 2020 to raise the share of gas in the fuel mix to 10 percent of China's total energy consumption and installing 70 GW of gas-fired power generating capacity to support fuel switching away from coal.[179] However, despite increasing production, demand outpaced supply in the past few years, leading to widespread fuel shortages of gas-fired power plants, hampering the successful promotion of fuel switching in power generation.[180] In recognition of these problems, the rhetoric and policy concerning the promotion of natural gas as a substitute for coal in the power sector has been toned down.[181] While the target of a 10 percent share in China's fuel mix by 2020 is still maintained, there are serious doubts as to whether the development of natural gas can stay ahead of the overall energy consumption growth to realise this objective.[182]

Deploying advanced coal technologies and increase coal use efficiency

Part of China's energy strategy is to pursue and deploy advanced coal technologies such as highly efficient supercritical and ultra-supercritical coal-fired plants, coal gasification and integrated gasification combined cycle plants, coal-to-liquid technology, and poly-generation such as in combined heat and power plants. With the exception of coal-to-liquid technology, all of these technologies are aimed at increasing the energy efficiency of China's consumption and could potentially achieve a significant demand reduction.

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[177] IEA, WEO 2007, p. 227. With respect to power plants, coal-fired power plants are estimated to emit 830-970 g CO_2 / kWh (depending on the coal quality), crude oil 590 g CO_2 / kWh and natural gas 390 g CO_2 / kWh. IEA, *CO_2 Emissions from Fuel Combustion*, 2007 edition, p. xxiv.

[178] BP, *Statistical Review of World Energy*, June 2009.

[179] Fridley, D. 'Natural Gas in China', Chapter 2 in: Stern, J., *Natural Gas in Asia*, Oxford University Press, 2008, p. 57.

[180] *China Daily*, 'Natural Gas Shortage May Force Power Plant Closure', 20 February 2006. Retrieved at http://www.redorbit.com/news/science/398799/natural_gas_shortage_may_force_power_plant_closure/ on 12 May 2009.

[181] The white paper states that China will "appropriately develop natural gas power generation". State Council, *China's Energy Conditions and Policies* (White Paper on Energy), December 2007, section IV. Moreover, in its *Natural Gas Utilisation Policy* (2007), the NDRC does not give a high priority to natural gas-fired power generation, even forbidding them under some circumstances. See: APERC, *APEC Energy Overview 2007*, January 2008, pp. 52-53.

[182] Fridley, D. 'Natural Gas in China', Chapter 2 in: Stern, J., *Natural Gas in Asia*, Oxford University Press, 2008, p. 59.

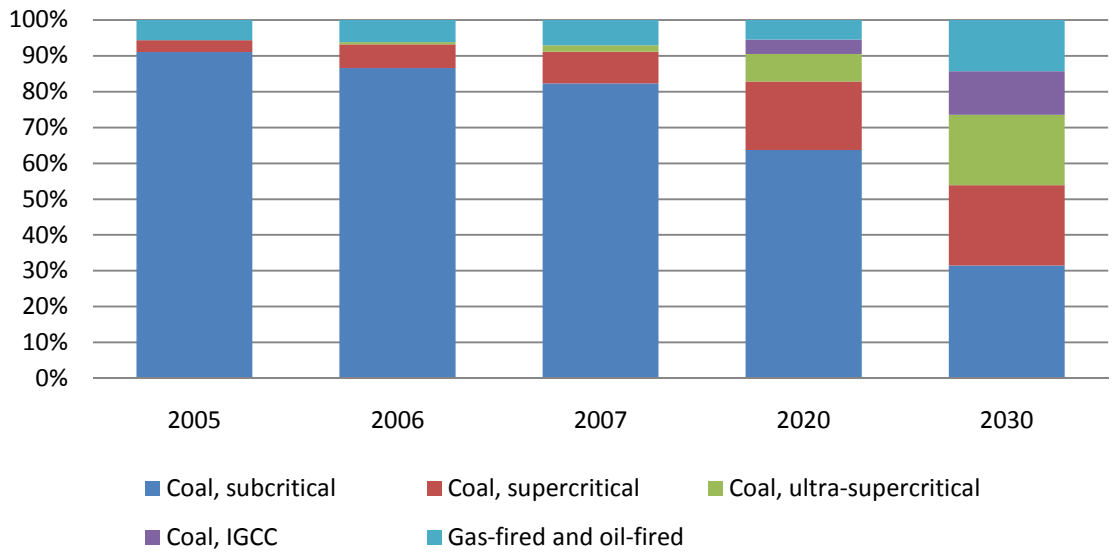

Table 4.5 Composition of China's thermal power generating capacity over the period 2005-2030. Chinese projections. Source: International Energy Agency, *Cleaner Coal in China,* 2009, p. 101.

Deployment of supercritical and ultra-supercritical power plants could have a big impact on improving the energy efficiency of Chinese coal-fired power plants, which account for 80 percent of the total generated electricity output. For example, the Chinese government itself estimates that the average efficiency of thermal power generation in general is 33.8%, about 6 to 7 percentage points lower than coal-fired plants in advanced developed countries.[183] Supercritical power plants perform at an efficiency level of 41-43%, while ultra-supercritical plants increase this ratio to 45-47%. With integrated gasification combined cycle technology, efficiency rates can reach more than 50%, while the additional benefits of poly-generation – electricity, heat and chemical products such as hydrogen – can be produced simultaneously.[184]

China has issued new regulations that require large newly built coal-fired power plants to be at supercritical or ultra-supercritical efficiency levels.[185] At the newest power plants now being built in China, generation efficiency runs at about 43 percent, an improvement of almost 9 percent.[186] Poly-generation is also promoted, which could raise overall fuel use efficiency for coal by another 10 to 20 percent. Considering that power generation accounts for 42 percent of the total greenhouse gas emissions, this

[183] National Development and Reform Commission, *China Medium and Long Term Energy Conservation Plan*, November 2004, p. 9. The difference is set at 6 percent in: Levine, Mark D., and Aden, Nathaniel T. (Lawrence Berkeley National Laboratory), *Global Carbon Emissions in the Coming Decades: The Case of China*, May 2008, p.22.

[184] Jiang, Zemin, 'Reflections on Energy Issues in China', Jiaotong University Journal, 2008.

[185] World Resource Institute, *Fact Sheet – Energy and Climate Policy Action in China*, 25 September 2008 (old version). Retrieved at http://pdf.wri.org/energy-climate_policy_action_in_china.pdf on 15 January 2009.

[186] International Energy Agency, *Cleaner Coal in China*, 2009, p. 102.

could have a quite significant effect: power generating efficiency improvements are thought to be able to save 110 Mt of CO_2 by 2010.[187] Apart from introducing modern highly efficient power plants, China is also shutting down the many small inefficient power plants in order to speed up the overall increase of thermal power generating efficiency. Since 2006, already more than 53 GW of these small-scale units has been shut down. There is an extra opportunity to push ahead with this process, as the current economic crisis is expected to lead to a temporary oversupply of power generating capacity. Table 4.5 shows the projected introduction of advanced coal-fired power plants in thermal power generation in China.

The development of coal-to-liquid technology

Coal liquefaction is one of the key technologies that China is pursuing in order to limit its rising oil import dependency. The first commercialised direct coal liquefaction plant in China has been built in Inner Mongolia by Shenhua Group, China's largest coal mining conglomerate. It has started operations in early 2009, with the annual output in the first phase amounting to 1 million tonnes of fuels – circa 20,000 barrels of synthetic oil per day.[188] However, plans are set to increase the output to 50 million tonnes by 2020 – around 286,000 barrels per day – and eventually convert about half of the coal production of coal-rich Inner Mongolia into liquid fuels and chemicals. Currently Shenhua Group is cooperating with Sasol and Shell on various coal liquefaction and coal chemical projects. A crucial aspect for the economic profitability of these expansion plans is the price of oil. Sources commercially involved in the projects mention that CTL projects in China could be profitable from US$40 upwards, while the Oil and Gas Journal estimated that a price of US$67 to US$82 would be needed, based on experience of the South African producer Sasol.[189]

The pursuit of coal-to-liquid technology is quite logical given China's large coal reserves and the energy security threat posed by its rising oil imports. Yet from a climate and sustainability point of view, it is a disastrous development. According to the International Energy Agency, the CO_2 emissions per unit of fuel produced by coal-to-liquid technologies are five to seven times higher than in a conventional refinery.[190] An additional problem is that the conversion process requires large amounts of water, while water resources are already scare in the areas of China where coal production centres are situated. Nonetheless, coal liquefaction remains a key technology for China in being able to limit its oil import dependency and main energy security threat, and it therefore receives significant government support.

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[187] Congressional Research Service, *China's Greenhouse Gas Emissions and Mitigation Policies*, 10 September 2008, p. 18, 21.

[188] *Bloomberg*, 'Shenhua Group starts China's First Coal-to-Fuel Plant', 6 January 2009.

[189] The bottom price of US$40 for Sasol's plants in China was mentioned by Sasol CEO Pat Davies in 2006, according to the article *Bloomberg*, 'Sasol, Shenhua Group May Complete Coal-to-Fuel Plant by 2013', 7 January 2009. Researcher Ning Chenghao at the Shenhua CTL institute in Shanghai estimated CTL production costs at US$45 per barrel in 2007 in *China Daily*, 'China launches first coal-to-liquids project', 6 January 2009. The price range US$67-82 is mentioned in *Oil and Gas Journal*, 'CTL deemed 'credible' fuel option despite drawbacks', Vol 106.16, 28 April 2008, pp. 28-29. *Reuters*, 'China builds plant to turn coal into barrels of oil', 4 June 2009. Retrieved at http://www.reuters.com/article/GCA-Oil/idUSSP13361320080604?sp=true on 13 May 2009.

[190] IEA, *WEO 2007*, p. 367. The IEA estimates that direct coal liquefaction has an energy-conversion efficiency of 60%, while indirect liquefaction reaches about 40%.

The prospects of carbon capture and storage in China

Carbon capture and storage (CCS) is a technology currently being developed for the prevention of carbon dioxide emissions that arise from fossil fuel combustion from being released into the atmosphere. A few different approaches have been designed, which all share the objective of separating out the carbon dioxide in order to allow it to be captured and stored. Storage should be permanent, and most options under consideration are underground sites such as depleted oil or gas fields, aquifers, rock salt caverns, non-recoverable coal beds or the ocean. Transport to storage locations could be done via pipelines or other means.

Since fossil fuels are expected to maintain their dominance in the world's energy system for quite some time to come, carbon capture and storage is regarded as a crucial technology for mitigating carbon emissions while a further transition to low-carbon energy sources is made. Estimates of the potential role of CCS in mitigating global carbon dioxide emissions are typically between 15 and 33 percent of the total achievable global CO_2 emissions reductions by 2050.[191]

With coal being the most carbon-intensive fossil fuel and China being the world's largest coal consumer, the urgent need for carbon capture and storage in China is a foregone conclusion. Yet, the road to implementation of carbon capture and storage in China is set to be long and difficult. It is hugely uncertain if CCS will be able to make a significant and, in particular, a *timely* contribution to mitigating China's emissions. According to the recent study by the International Energy Agency on coal in China, CCS is unlikely to be implemented in China on a large scale before 2030.[192] However, in the scenario work done by the British Tyndall Centre which focuses on a carbon budget for China, a rapid introduction of CCS in China already before 2030 plays an essential role in achieving emissions reductions that could limit CO_2 concentration levels to 450 ppm.[193]

To give an indication of the challenges ahead: the current largest CCS projects in operation at Sleipner (Norway), Weyburn (US/Canada) and In Salah (Algeria) store approximately 4 Mt of CO_2 per year.[194] In comparison, Chinese CO_2 emissions totalled 4,100 Mt of CO_2 in 2004 and are increasing by more than 4 percent per year.

To encourage the development of CCS in China, a number of international cooperation projects have been set up. One of those initiatives is the Near Zero Emission Coal project

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[191] Clingendael International Energy Programme, *Carbon capture and storage: a reality check for the Netherlands*, Clingendael Energy Paper, September 2008.

[192] International Energy Agency, *Cleaner Coal in China*, 2009, p. 106. Also see IEA, *WEO2007,* pp. 347-348.

[193] According to the IPCC and IEA (*WEO2008,* p. 407), this target of 450 ppm for CO_2 would correspond approximately to 550 ppm of CO_2e for all greenhouse gases and a potential (mean) temperature rise of about 3˚ Celsius. The Tyndall Centre has outlined four different future scenarios based on a carbon budget for China up to 2100. In most of them CCS plays a very significant role, becoming mandatory for fossil fuelled power plants after 2020 (S1&S3) and in a few scenarios reaching a penetration rate of 80% (S3) and 90% (S4) by 2050. See: Wang, Tao and Watson, Jim, *Carbon Emissions Scenarios for China to 2100*, Tyndall Centre, September 2008; Wang, Tao and Watson, Jim, *China's Energy Transition. Pathways for Low Carbon Development*, Tyndall Centre, 2009.

[194] International Energy Agency, *World Energy Outlook 2007,* p. 219.

set up by Great Britain/E.U. and China. The goal of the project is to build a near-zero emission coal power plant in China by 2014 after the preliminary research and capacity building.[195] The European Union is also participating in a cooperation project with China on developing CCS regulation together with China.[196]

The United States has prioritised carbon capture and storage as one of the key items on the US-China energy and climate cooperation agenda, which was launched by Secretary of State Hillary Clinton during her visit to China in February 2009.[197] As both countries are the world's largest coal consumers and CO_2 emitters, this is a laudable and potentially very fruitful initiative. Yet the development of CCS in the United States itself has been quite slow and has suffered some severe setbacks. In 2003 the United States launched the FutureGen project with the objective of establishing the world's first zero-emissions coal-fired power plant using integrated gasification combined cycle technology, but the project was put on hold in 2008 after it repeatedly exceeded the allocated budget. This has been particularly embarrassing since the Chinese actually joined the project, by participation of the China Huaneng Group, China's largest coal-fuelled power generator.[198] As of June 2009, the project is being reconsidered under the Obama administration and might be implemented in a scaled-down version.[199]

The Chinese have also launched their own integrated gasification combined cycle power plant project, GreenGen, which is eventually to include carbon capture and storage. The first phase involves a 250 MW IGCC plant scheduled to come online in 2010. In the second and third phases the capacity will be extended to 650 MW, and carbon capture and storage facilities will be added in the last phase.

Even if it were possible to scale up these demonstration projects quickly, major hurdles remain with respect to CCS implementation in China. Applying CCS is quite energy-intensive in itself and a power plant with CCS would require 10 to 40 percent more energy for the same power output compared to a power plant without CCS.[200] Second, power generation costs are estimated to be 75 to 100 percent higher compared to conventional steam cycles.[201] There is already some experience with the requirement for Chinese coal-fired plants to install so-called flue-gas desulphurisation (FGD) equipment, which filters SO_2 from the exhaust gases. Sulphur dioxide is a major pollutant causing acid rain and health risks and has a direct impact on the local environment. However, running the FGD equipment causes a 4 to 8 percent reduction

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[195] *China Daily*, 'Joint carbon project launched', 21 November 2007. Retrieved at http://www.china.org.cn/english/China/232530.htm on 6 January 2009.

[196] Support to Regulatory Activities for Carbon Capture and Storage ($STRACO_2$). See: http://www.euchina-ccs.org.

[197] Two thorough and detailed reports on U.S.-China cooperation on energy and climate change were launched prior to the visit by Mrs. Clinton: Asia Society/Pew Center on Global Climate Change, *A Roadmap for U.S.-Chjina Cooperation on Energy and Climate Change*, January 2009; Lieberthal, K. and Sandalow, D., *Overcoming Obstacles to U.S.-China Cooperation on Climate Change*, The Brookings Institution, 2008.

[198] FutureGen Alliance press release, 27 October 2005. Retrieved at http://www.futuregenalliance.org/news/releases/pr_10-27-05.pdf on 18 May 2009.

[199] *Bloomberg*, 'FutureGen 'Clean Coal' Project Scaled Back by Obama', 12 June 2009. Retrieved at http://www.bloomberg.com/apps/news?pid=20601130&sid=aGjTXcurNFBo on 28 July 2009.

[200] IPCC, Special Report, *Carbon Capture and Storage – Summary for Policymakers*, 2005, p. 4. Retrieved at http://www.ipcc.ch/pdf/special-reports/srccs/srccs_summaryforpolicymakers.pdf on 15 January 2009.

[201] International Energy Agency, *Cleaner Coal in China,* 2009, p. 107.

in production efficiency and raises the final prices. As a consequence, even when they *have* the equipment installed, the Chinese operators often do not turn it on in order to save money.[202] Environmental agencies lack the capacity for enforcement, and the fines for breaching the regulations are too low to form an incentive for action. So even with the direct and local environmental impact caused by the emissions of SO_2, the application of FGD is greatly impeded. This does not bode well for the large-scale introduction of CCS.

4.3 The need for reform and for effective enforcement of policy

If the Chinese government is to commit to even stronger policy on energy, environment and climate it will need a strong regulatory system to implement these measures. Historically, however, governmental authority concerning energy policy in China has been quite fragmented. Environmental protection has suffered even longer from neglect. Yet both are crucial to making sure China will realise its potential in mitigation emissions.

Energy and environment in Chinese overall policy-making

The progress in centralising energy policy in China has been long and arduous.[203] For a long time it was the National Reform and Development Commission (NDRC) – the powerful commission in charge of the general macro-economic planning – that has controlled most of China's energy policy.[204] However, in March 2008, after long deliberations, the National Energy Administration was created out of the Energy Bureau under the National Reform and Development Commission. The new National Energy Administration has vice-ministerial rank and is supposed to manage the country's energy industries, draft policy and approve overseas energy investments. However, it still misses out on some key decision-making powers, the most important one being the authority to set energy prices, which still remains with the NDRC.[205] After a long history of bureaucratic reshuffling, observers remain rather doubtful if the administration can really deliver on the high expectations placed on it.[206] In particular it will have to deal with the more powerful NDRC and the strong political influence of the Chinese oil majors (CNPC, Sinopec and CNOOC), coal producing conglomerates and power companies which are known to push for supply-side investments at the cost of measures limiting demand such as the promotion of energy efficiency and conservation.[207]

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[202] Rosen, D.H., and Houser, T., *China Energy. A Guide for the Perplexed*, May 2007, p. 11.

[203] See: Part 3. 'China's Energy Policymaking Apparatus: Ineffective Institutions and Powerful Firms', in Downs, Erica, *China*, The Brookings Institution, Energy Security Series, Dec 2006.

[204] Downs, Erica S., 'The Chinese Energy Security Debate', *China Quarterly,* vol. 177, March 2004, pp. 24-31. The NDRC was previously named the State Development Planning Commission prior to the bureaucratic reorganisation of March 2003.

[205] *China Economic Review*, 'NDRC will continue to set energy prices', 25 March 2008. *Caijing Magazine*, '张国宝称能源局不应谋求定价', [Original text in Chinese. Zhang Guobao cheng nengyuanju buying mouqiu dingjiaquan: "Zhang Guobao says the National Energy Administration should not strive for authority to set prices"), March 24, 2008.

[206] Downs, Erica S., 'China's "New" Energy Administration', *China Business Review*, November-December 2008. Tu, Jianjun, 'China's New National Energy Commission and Energy Policy', Jamestown Foundation *China Brief*, vol. 8 no. 7, 28 March 2008. Zhang, Libin and Lee, Jason, 'Untangling China's Energy Policy', *China Security*, no. 11 (summer) 2008.

[207] Exemplifying this bond, CNPC and Sinopec are placed in China's bureaucratic system as ministry-level corporations, with the general managers holding vice-ministerial rank.

A second impediment for the proper functioning of the National Energy Administration is its lack of staff and capacity for designing, implementing and enforcing policy. The headquarters of the new administration has only has slightly more than 100 staff members, which pales in comparison to the U.S. Department of Energy's total of 15,000 employees with over 600 people engaged in statistical data collection at the Energy Information Administration alone.[208] This means that the energy agencies often have to rely on the state energy companies for policy support and advice, considering their larger human and financial resources.[209] Hence, the manoeuvring space for independent policy making on energy is rather constrained.[210]

A similar pattern of periodic reshuffling can be discerned in the governmental organisation of environmental protection. Often neglected in favour of economic development and the growth of gross domestic product, environmental protection has had to fight its way up the political agenda in a tough prolonged struggle. Ten years after its establishment in 1988 the State Environmental Protection Administration was upgraded to a ministry-level agency, but it took until the latest reforms in March 2008 before the administration became a full-fledged Ministry of Environmental Protection. However, 'full-fledged' might not be the most appropriate description. Like the National Energy Administration, the authority of the Ministry is still weak in the face of other vested powers, and its effectiveness is severely hampered by a lack of staff. As in other aspects of Chinese governmental policy, the crucial weakness is not so much about not having the right regulation and laws, but about ineffective enforcement. The central government has traditionally judged the performance of local governments by the extent of them meeting their targets for GDP growth. In addition, local officials often fail to act against pollution out of self-interest, having personal relationships with factory owners or even direct financial stakes in the companies.[211]

The lack of priority being given to the enforcement of environmental policies expresses itself in the number of staff allocated to the environmental agency. The new Ministry of Environmental Protection has started off with only about 300 workers at the headquarters in Beijing and about 30 people in each of the five regional inspection offices, which are supposed to monitor all provinces. Considering that they have to monitor one of the largest and most populous countries in the world, it is obvious that the Ministry is not equipped for the task. In contrast, the U.S. Environmental Protection Agency has more than 17,000 employees not including outside contractors, with almost 9,000 in Washington, D.C. alone.[212] In China, monitoring of environmental conditions on a local level is done by approximately 2,500 local environmental protection bureaus which together employ about 60,000 people.[213] This greatly increases the manpower

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[208] Plus another 95,000 contractor employees. See: U.S. Department of Energy, *Performance and Accountability Report Highlights: Fiscal Year 2006*, p. 3; Rosen, D.H. and Houser, T., *China Energy. A Guide for the Perplexed*, May 2007, p. 18.

[209] Downs, Erica, *China*, The Brookings Institution, Energy Security Series, December 2006, p. 24.

[210] Kong, Bo, 'Institutional Insecurity', *China Security*, Summer 2006.

[211] He, Gang, 'China's New Ministry of Environmental Protection Begins to Bark, but Still Lacks in Bite', EarthTrends / World Resource Institute, 17 July 2008. Economy, Elizabeth C., 'The Great Leap Backward?', *Foreign Affairs*, September / October 2007, pp. 43, 51-52.

[212] He, Gang, 'China's New Ministry of Environmental Protection Begins to Bark, but Still Lacks in Bite', EarthTrends / World Resource Institute, 17 July 2008.Economy, Elizabeth C., 'The Great Leap Backward?', *Foreign Affairs*, September / October 2007, p. 51.

[213] U.S. Council on Foreign Relations, 'China's Environmental Crisis', 4 August 2008. Retrieved at http://www.cfr.org/publication/12608/#p6 on 20 May 2009.

employed in the field of environmental protection. However, the environmental agencies at the provincial level are funded and staffed exclusively by the local government, not the central government, weakening their capacity for independent judgement and enforcement.

The need for reform and capacity building on climate change

The National Energy Administration and the Ministry of Environment are two of the most prominent government institutions that will be involved with implementing China's policy on climate change. That they could profit from further reforms and an expansion of mandate and authority is clear from the analysis above. Together with other government departments, their proper functioning will be critical to successfully enforcing energy efficiency standards in buildings, appliances, vehicles and industry; assessing the sustainability and environmental impact of new projects; and making sure that the right incentives are in place to change China's developmental path.

With respect to climate change in particular, there is the need for China to develop a system capable of monitoring emissions and progress on mitigation goals. As for many developing countries, it has been difficult for China to supply accurate greenhouse gas emissions inventories. Yet these form the basic necessity for implementing any mitigation policies and assessing their effectiveness. Without such capacity China will not be able to comply with the requirement agreed upon in Bali that all mitigation efforts should be measurable, reportable and verifiable. Establishing a comprehensive emissions monitoring system in a country as large and populous as China is a rather daunting task, but it is crucial to making progress.[214] As China will move towards stricter targets and hopefully to some kind of carbon pricing or cap-and-trade system in future, this is a first step.

Encourage pricing reform and the use of financial incentives

China has a strong potential asset in hand that can encourage energy efficiency and make possible a transition to a more sustainable energy system, namely the reform of its system of regulated energy prices. Although China has made much progress in eliminating price subsidies, energy prices are still rather low and do not provide a very strong financial incentive to limit demand and spur energy efficiency. To achieve the huge potential energy efficiency benefits that are present in the Chinese economy, reform of energy prices could be a very powerful tool.

Traditionally, China has used pricing controls over electricity, natural gas, gasoline and other petroleum products to shield its citizens from energy prices deemed to be too high, and this mechanism is seen as an important instrument to maintain social stability and encourage economic development.[215] However, multiple drivers are pushing China to reform the pricing system. One is that the gasoline and diesel pricing system has come under increasing strain with the rising oil imports and continuing integration in the global oil market. International oil price volatility has led to considerable market distortions in the past, having very negative effects for either the domestic consumers or

[214] Hilton, I. and Mabey, N., panel discussion at the conference 'Europe and China. A Strategic Dialogue' organised by Friends of Europe and the Security and Defence Agenda (SDA), Brussels, Belgium, 19 May 2009.

[215] International Crisis Group, *China's Thirst For Oil*, Asia Report No. 153, June 2008, p. 8.

the downstream business of the national oil majors.[216] The problems in the power sector caused by the tension between the liberalised internal raw coal market and the regulated electricity prices form a second driver for reforms.

The drop in international oil prices due to the financial and economic crisis has given the Chinese government the opportunity to make some structural adjustments to the pricing regime. A first step has been taken by instigating a significant increase of the fuel tax on petroleum products as of January 2009, raising the share of taxes in the final retail price from 3-4 percent to nearly 18 percent.[217]

Raising the fuel tax was a good first step, but the effect was neutralised immediately by the drop in international oil prices. In fact, this is the very reason why the fuel tax reform was able to be implemented at all. Although the policy of protecting its population from high energy prices is an understandable objective, China will only be able to advance its energy efficiency goals if it is willing to support them with economical incentives. For this to be achieved, a reform of the pricing system is essential.[218]

4.4 China as an economic competitor

China's engagement in renewable energy and advanced energy technologies is not only motivated by its own energy security and environmental concerns, but also by economic considerations: it is preparing itself to be the new economic powerhouse in these fields.

The white paper on climate change, *China's policies and actions on climate change*, mentions the following objectives:

> "China is determined to develop rapidly more of its wind-power potential so that industrialisation can be achieved. It will raise its capacity for developing and manufacturing wind-power equipment (…)."
>
> "It will strengthen its capacity for developing and manufacturing nuclear power equipment, and raise its ability to absorb imported technology and make new innovations on this basis."
>
> "Through importation, absorption, digestion and self-innovation, some advanced technologies with proprietary intellectual property rights have emerged, in particular a group of key technologies which play a leading role in respective sectors have been developed, demonstrated and popularized."[219]

In addition, the *National Climate Change Programme* aims at the following:

> "… realize domestic manufacturing of wind power equipment to reduce costs and improve market competitiveness of wind power as early as possible."

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[216] Downs, Erica, *China*, The Brookings Institution, Energy Security Series, December 2006, pp. 26-27.

[217] Andrews-Speed, Philip, 'China's higher fuel taxes: a step forward or more headaches for the government?', Centre for Energy, Petroleum and Mineral Law and Policy Gateway, 5 January 2009. Andrews-Speed, Philip, 'China: Oil prices, subsidies and rebates – where do we go from here?', Centre for Energy, Petroleum and Mineral Law and Policy Gateway, 9 April 2008.

[218] International Energy Agency, *World Energy Outlook 2008*, p. 96.

[219] State Council Information Office, *China's Policies and Actions for Addressing Climate Change* [White Paper], October 2008.

> "… realize independent and domestic construction of large-scale nuclear power stations and improve the overall capacity of nuclear power industry by the principle of self-dependence."[220]

The analysis that was presented in Chapter 2 shows that for wind power and nuclear energy, China is progressing very well towards its objectives. The government has been very successful in both instances in forcing technology transfer upon foreign partners to jumpstart a domestic industry. For wind power, Chinese manufacturers have sprung up and pushed back the market share of international players from 75 percent to 44 percent in only three years' time.

For nuclear energy, development is still in progress, but the deal on nuclear reactors awarded to Westinghouse in 2007 included a contractual agreement on technology transfer, explicitly enabling the Chinese to build further units on their own. Moreover, technological cooperation has been set up to design an improved and enlarged version of the Westinghouse AP1000 reactor for possible export.

Yet wind and nuclear energy are not the only areas on which China is focusing. It has been pursuing advanced technologies ranging from low-energy lights, solar cell and panel manufacturing, electric and hybrid cars, fuel cell technology, high voltage long distance transmission grid technology and advanced coal technologies such as coal-to-liquid processes, coal gasification and carbon capture and storage.

In the field of advanced coal technology, some claim that China is already ahead of the United States in some fields, for instance in implementing coal gasification plants. Reportedly, China will have installed 29 coal gasification projects in the period 2004-2010, compared to zero in the United States. The Chinese integrated gasification combined cycle project GreenGen has broken ground, while the similar U.S. FutureGen project has been stalled due to budget overruns.[221]

Electric cars and hybrid vehicles are another crucial sector in which China is trying to get ahead. Already the biggest car market in terms of sales since the beginning of 2009, the Chinese government has expressed its ambition to manufacture 500,000 electric vehicles by the year 2011. Apart from support for research in this field, the state is also offering subsidies to buyers of electric cars. The country's largest electric power company, the State Grid Corporation of China, is setting up charging stations in larger cities like Beijing and Shanghai. The Chinese lithium battery manufacturer BYD has launched its first mass-produced plug-in hybrid car, which should be able to drive up to 100 km on stored grid power alone.[222] With a very competitive manufacturing industry and a well-developed battery and fuel cell sector, China is very well positioned to take advantage of the launch of this technology internationally.[223]

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[220] NDRC, *China's National Climate Change Programme,* June 2007.

[221] *MIT Technology Review*, 'China Closes the Clean-Coal Gap', 17 December 2008. Retrieved at http://www.technologyreview.com/energy/21887/page1/ on 10 January 2009.

[222] *MIT Technology Review,* 'China's New Green Machine', 16 December 2008. Retrieved at http://www.technologyreview.com/blog/energy/22465/ on 10 January 2009.

[223] *New York Times*, 'China Outlines Plans for Making Electric Cars', 10 April 2009. Retrieved at http://www.nytimes.com/2009/04/11/business/energy-environment/11electric.html?_r=1&partner=rss&emc=rss

All these technologies hold great promise for mitigation climate change. China is trying to apply these technologies to the domestic market, but the next step will certainly be to exploit the international market and sell them abroad. As international players are being pushed aside in the Chinese market in many cases, it is only a matter of time until the Chinese companies will enter the international market.

In terms of reaching a deal in Copenhagen, this development might be both an advantage and a disadvantage. Fear of economic competition and losing technological advantages has made some developed countries more reluctant to provide financial support and technology transfer to mitigate climate change in China and other developing countries. The United States is a prime example, where the House of Representatives passed an amendment to the Foreign Relations Authorization Act to establish a clear policy "in opposition to any global climate change treaty that weakens the intellectual property rights of American green technology". The amendment, known as the Larsen-Kirk Compulsory Licensing Amendment, "requires the President, the Secretary of State and America's U.N. Ambassador to oppose any climate change treaty that would weaken intellectual property rights related to energy or environmental technology."[224]

Yet the growth of 'green' industries in China may also be a reason to cooperate in order to encourage the quickest diffusion of low-carbon technologies worldwide. Certainly the added incentive of economic profit will be a valuable driver toward bringing China to the table in Copenhagen for the promotion of alternative energy and low-carbon technologies.

4.5 The impact of the financial and economic crisis

The financial and economic crisis that emerged in the second half of 2008 has already had a tremendous impact on the world economy, global power relations and the international energy sector. As for the climate treaty negotiations scheduled at Copenhagen in December 2009, it adds another complicating factor.

In the years leading up to the oil price spike in the summer of 2008, the fundamental imbalance between oil supply and demand constrained oil markets and drove up global oil prices.[225] It posed an alarming signal, illustrating in a most vivid way that the current growth trajectory of our energy system is simply not sustainable in the long run. It also gave a powerful stimulus to the development of alternative energy resources and the serious implementation of energy efficiency and energy conservation, both important steps towards transforming our energy system in a different, more sustainable fashion.

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on 14 April 2009. *Far Eastern Economic Review*, 'The Race for China's Electric Car, 20 April 2009. Retrieved at http://www.feer.com/economics/2009/april53/The-Race-for-Chinas-Electric-Car on 22 April 2009.

[224] *China Environmental Law,* 'U.S. House to China: Handds Off Our Climate Technology', 12 June 2009. Retrieved at http://www.chinaenvironmentallaw.com/2009/06/12/us-house-to-china-hands-off-our-climate-technology/ on 25 August 2009.

[225] Jesse, Jan Hein, and van der Linde, Coby, *Oil Turbulence in the next decade: an essay on high oil prices in a supply constrained world*, The Hague: Clingendael International Energy Programme, 2008; Ten Kate, Warner, and van Geuns, Lucia, 'Turmoil on the International Oil Markets: Getting Used to Production Capacity Constraints,' in *Challenges in a Changing World. Clingendael Views on Global and Regional Issues*, de Zwaan, Jaap; Bakker, Edwin, and van der Meer, Sico (eds.). The Hague: TMC Asser Press, 2009.

While the economic crisis has lowered global economic output and contributes to curbing emission levels, the more fundamental impact on the global transition to a low-carbon energy system is quite negative. The slump in fossil fuel prices has lessened the competitiveness of alternative energy resources and reduced the financial incentive for demand reduction. Companies involved in renewable energy sources, such as wind and solar energy, have taken a severe hit and are being forced to scale down their operations.[226]

With the oil price hike of the summer of 2008 still fresh in mind, many world leaders have rallied behind the idea of a 'Green New Deal' to combat the economic downturn, modelled after the investment in big infrastructural projects by the U.S. government under Franklin D. Roosevelt in the 1930s in the midst of the Great Depression. Applied to the current situation, financial stimulus packages are utilised to encourage growth in renewable energy programmes and establish a low-carbon economy. To what extent these programmes will actually achieve this ambitious goal remains to be seen.

Despite all rhetoric, it will be very difficult for government to act as a substitute for favourable market conditions in the development of low-carbon technologies. Moreover, there has been quite some criticism on the exact 'green' content of the various stimulus packages in different countries. At the bottom line, the priority lies with stimulating the economy, not with making a low-carbon transition.

Impact on China's domestic situation

It appears as if China has emerged out of the crisis relatively unscathed. Economic reports coming out of China showed positive signs of healthy industrial output in the first quarter of 2008 despite a major drop in exports. The Chinese banking system escaped the worst blows of the financial crisis, benefiting from a limited exposure to the collapsed financial institutions in the United States. The incomplete global integration of China's monetary and financial system has proven a valuable asset in overcoming this crisis, as it was in the Asian financial crisis of 1997.

The Chinese government is very confident about China's capability to address the crisis, as Premier Wen Jiabao declared at the World Economic Forum at Davos in January 2009. It has issued a massive stimulus package of 4 trillion Chinese yuan, equivalent to US$586 million, and maintains that it will be able to achieve the goal of an economic growth rate of 8 percent (the *baoba*, or 'maintain the eight', policy). This is a significant drop from the double-digit growth rates of recent decades but still an enormous advance compared to the recession impact in developed countries.

Despite all optimism, there are also reasons to doubt if China will be able to weather the crisis that smoothly. The recession in many of the developed countries' economies has strongly reduced global demand, particularly affecting the export-oriented Chinese economy.[227] Foreign trade in January 2009 was down 29 percent compared to one year earlier, with exports dropping by almost 24 percent. In February it was reported that manufacturing centres like Shenzhen and Dongguan in the southeast coastal province

[226] International Energy Agency, *The Impact of the Financial and Economic Crisis on Energy Investment*, 2009.
[227] In 2007, exports amounted to 34.7% percent of China's gross domestic product. *CIA World Factbook - China*. Retrieved at https://www.cia.gov/library/publications/the-world-factbook/geos/ch.html, on 10 Feb 2009.

Guangdong were badly hit. Reportedly, one tenth of local enterprises had to shut down, this figure being as high as 30 percent for labour-intensive enterprises where a similar percentage of migrant workers were dismissed.[228] In order to prop up companies that have come in financial troubles, Chinese banks have massively increased their lending with the tacit support of the government. New loans issued in January 2009 alone totalled 1.62 trillion Chinese yuan, almost one-third of the total lending for 2008.[229]

This massive injection of liquidity is keeping the Chinese market afloat for the time being, yet in order to truly deal with a global recession China will need to transform its economic system from being export-led to an economy driven by domestic demand.[230]

Impact on China's energy sector

The unfolding crisis also has a significant impact on China's energy sector. First of all, it is caused a temporary drop in demand. The Chinese National Energy Administration reported that overall electricity consumption over the four months from January to April this year was down 4 percent compared to last year, while oil imports had dropped by 4.5 percent. The incompatibility of these figures with the reported first quarter GDP growth of 6.1 percent has led some analysts, including the International Energy Agency, to question the accuracy of recent Chinese GDP statistics.[231]

The sudden drop in economic growth is expected to lead to an oversupply of power generating capacity. As the need for high-speed expansion has receded for the moment, it offers China the chance to press on with promoting nuclear and renewables versus coal. Zhang Guobao, the head of the National Energy Administration, has declared that he wishes to use the opportunity to reform China's energy pricing system and to clamp down on small inefficient power plants, of which he aims to shut down about 13 GW in 2009.[232] Even though lower energy prices have decreased the competitiveness of renewables, it is reported that investment in coal-fired capacity dropped in 2008 by 22 percent, while it increased for wind and nuclear by 88 percent and 72 percent, respectively.[233]

Assessing China's stimulus package and the effects on climate change policy

The 4 trillion Chinese yuan stimulus package has received quite some acclaim as being one of the world's largest "green" stimulus programmes, with almost 40 percent going to

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[228] *Caijing Magazine*, 'Pearl River Delta: Skyrocketing Growth Halts', 5 February 2009. Retrieved at http://english.caijing.com.cn/2009-02-05/110053048.html at 19 February 2009; *China Daily*, 'Guangdong reports 31% drop in Jan foreign trade, 17 February 2009. Retrieved at http://www.chinadaily.com.cn/bizchina/2009-02/17/content_7485592.htm on 19 February 2009.

[229] *China Daily,* 'Lending soars in new year', 23 February 2009. Retrieved at http://chinadaily.cn/bizchina/2009-02/23/content_7501297.htm on 23 February 2009. Total lending over 2008 stood at 4.9 trillion yuan.

[230] *Caijing Magazine,* 'Reform, Not Liquidity, Is the Way Out', 16 March 2009.

[231] *Energy Daily*, 'China defends economic data amid questions over energy use', 1 June 2009; 'Another Chinese Riddle: How Reliable Are GDP Figures?' in: International Energy Agency, Oil Market Report, 4 May 2009, p. 15.

[232] *China Daily,* 'King coal losing his power in electricity industry', 16 February 2009. Retrieved at http://www.chinadaily.com.cn/bizchina/2009-02/16/content_7478767.htm at 18 February 2009. *China Daily*, 'Green energy projects increase', 30 March 2009.

[233] *China Daily,* 'Investment in nuclear and wind power soaring', 6 January 2009. Retrieved at http://www.china.org.cn/business/2009-01/06/content_17065404.htm on 10 January 2009.

projects benefiting the environment.[234] Yet upon closer inspection, most of these so-called "green" investments are going into infrastructural projects such as railway expansions, electricity grid upgrading and water treatment.[235] Most certainly, the investments in railway expansion and electricity grid upgrading might contribute to low carbon energy goals, as the first might substitute for other types of transport and the second can prepare China to deploy more renewable energy sources. Yet these investments can also be seen as simply part of a general development strategy, as both sectors are essential regardless of the sustainability of this development. While these investments are not increasing energy consumption or emissions, they also do not directly contribute to the sustainability of China's energy system, as they do not include any specific support of renewable energy development or energy efficiency and conservation.

In fact, a large part of the stimulus is devoted to housing, as one of the key objectives of the stimulus package is to sustain the construction industry in China, among them the iron, steel, cement sectors.[236] Hence, the gain for sustainability and climate change is expected to be rather marginal. Further measures to spur the economy back into action are also reversing some progressive policy on sustainability. The tax rebates on energy- and pollution-intensive products, which were revoked earlier to discourage these types of goods, have largely been set back to their original level.[237] Sales taxes for small cars have been halved as well, in an attempt to spur car sales.

Economic development has always been the top priority of the Chinese government, and this has only been reinforced with the unfolding of the global financial and economic crisis. For many developed countries, fears about rising unemployment and possible social unrest have downgraded concerns about climate change vis-à-vis economic recovery. Naturally, this is all the more true for China, where climate change has only a minor influence on government policy and concerns about social stability are paramount. The economic crisis offers some opportunities for China to reform its energy system. Overall, however, it will certainly add to the reluctance towards making strong commitments in Copenhagen.

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[234] HSBC, *A Climate for Recovery. The colour of stimulus goes green*, February 2009.

[235] World Resources Institute, "A "Green Lining" in China's Economic Stimulus Plan", 26 Nov 2008. Retrieved at http://www.wri.org/stories/2008/11/green-lining-chinas-economic-stimulus-plan on 20 Jan 2009.

[236] Andrews-Speed, Philip, 'China's economic stimulus package: implications for climate change and energy efficiency', Centre for Energy, Petroleum and Mineral Law and Policy Gateway, 11 November 2008.

[237] *China Daily,* 'China hikes export tax rebates', 28 March 2009. Retrieved at http://www.chinadaily.com.cn/bizchina/2009-03/28/content_7626129.htm on 5 April 2009.

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Discussion

After the two major United Nations climate summits at Bali and Poznan, eyes are focused on the fifteenth Conference of the Parties at Copenhagen in the hope that a global deal will be reached addressing the four building blocks of mitigation, adaptation, technology transfer and finance. After limited progress in earlier talks, a comprehensive accord is especially crucial in Copenhagen since the first commitment period of the Kyoto Protocol is expiring in 2012. Uncertainty about the future of emission trading mechanisms and the imposition of stringent targets is hampering the proper functioning of carbon markets and is having a negative impact on the price of carbon. Carbon markets as well as related industry investment decisions are all pending upon a renewed significant move and signal of commitment at Copenhagen.

Although the Kyoto Protocol signified a milestone in the global response to climate change, the implementation of the mitigation targets has proven to be extremely tough for the Annex-I countries that took up binding commitments. Support for the whole effort has faltered even among some of these advanced developed countries, with the most conspicuous example being the United States pulling out of the Kyoto process and only reversing its position under the new presidency. Given this experience, it comes as no surprise that China and other developing countries are extremely reluctant to place themselves in a comparably difficult position.

The analysis of China's current policies regarding energy and climate makes clear that these topics have risen to the top of the political agenda of Chinese leadership. Without a doubt, positive action is being undertaken on a large scale in China to mitigate the rapid growth of energy consumption and reduce the associated risks concerning energy security and environmental impact. Despite these efforts, however, recent trends and future projections show that the developmental path now being followed by China is unsustainable and will have huge environmental consequences, in particular for global warming.

This grim reality sets the scene for the negotiations to be held in Copenhagen. In this chapter we will present our findings and discuss the crucial role of China in any global effort to address climate change, its negotiating stance, some key features of energy developments in China, possible leads in the negotiations, as well as the geopolitical circumstances that shape the boundaries of what can be achieved.

5.1 We need a deal now and China is crucial

The research presented by the Intergovernmental Panel for Climate Change compellingly shows the dramatic effects that a temperature rise of more than 2˚C could have on the Earth's environment and global living conditions. Yet with the current

growth pattern of energy consumption and emissions worldwide, it is already nearly impossible to achieve stabilisation at this level: it would require global emissions to peak in the next few years before 2015, and drop sharply afterwards. Even stabilising the concentration of greenhouse gases in the atmosphere in time to limit the global temperature increase to 3˚ C would require immediate and drastic action in order to halt global emissions growth by 2025. Although the exact required timing of the global emissions peak depends on the speed of emission reductions later on, it is clear that to have a chance of success in reducing greenhouse gas emissions, action will need to be taken now and on a far larger scale than has been done up to this moment.

The crucial role of China in curbing global emissions

Mitigating China's greenhouse gas emissions in the near future is crucial if the world is going to be able to achieve any kind of greenhouse gas stabilisation goal. As the world's largest emitter, China's share in global CO_2 emissions already exceeds 20 percent, and these are expected to rise to almost 30 percent by 2020 according to current forecasts – which might very well turn out to be a conservative estimate. Instead of slowing down, China's greenhouse gas emissions have *accelerated* in the past few years, outpacing all previous projections. According to the Reference Scenario of the International Energy Agency released in 2008, China will account for approximately half of the increase in global greenhouse gas emissions between now and 2030.[238]

If only because of the size of its current and future emissions, China's participation is key to the success of a global mitigation programme. To accommodate rising emissions in China while at the same time lowering global emissions would require cuts in developed countries on a massive and unrealistic scale. As a bleak illustration of this fact, suppose one would still aim at a greenhouse gas stabilisation target of 450 CO_2-eq ppm – considered to be equivalent to a fifty percent chance of limiting the global temperature rise to 2˚ C – the mitigation potential of OECD countries is projected to be simply insufficient to achieve the necessary reduction of greenhouse gases. Even in the hypothetical case that the OECD countries would reduce their emissions to zero by 2030, the 450 ppm trajectory would not be met.[239]

The massive potential of mitigation measures in China

The second reason why China is of crucial importance in the global mitigation efforts is that it holds the largest opportunities for reducing emissions. These opportunities fall into a couple of categories, but there are two main themes: one is that Chinese energy consumption is still hugely inefficient compared to advanced international standards and therefore that there are enormous gains to be made through bringing energy use down to a more efficient level, often even with net profits. The other theme is that China is in the process of rapidly expanding its energy system and there is still a chance of steering this development in a more sustainable direction. The explosive growth of housing construction, power generation capacity and transport is by no means exhausted, which still gives an opportunity to avoid the "lock-in" of carbon-intensive technologies.

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[238] This is calculated from the Reference Scenario in: International Energy Agency, *World Energy Outlook 2008*, p. 385.

[239] International Energy Agency, *World Energy Outlook 2008*, p. 418.

To take one key example, we can look at the development of power generation capacity in China, which accounts for half of all coal consumed in China and almost half of all domestic CO_2 emitted. At this moment, China is laying the foundation of its power sector for the decades to come. The implications of the manner in which this foundation is being laid, from an environmental and climate perspective, cannot be overstated.

This crucial sector has been expanding at a tremendous pace. In the past few years, around 90-100 GW of capacity has been added each year, corresponding roughly to the size of the complete power sector of the United Kingdom.[240] Despite all support for renewable energy, by far the most of the newly installed capacity consists of coal-fired power plants, which are being built at a rate of three to four 500 MW plants per week. Each one of them adds 3 million tonnes of CO_2 to China's annual greenhouse gas emissions. Given the lifespan of these plants, these emissions will be sustained over the next four to five decades unless carbon capture and storage becomes widespread – but the large costs associated with retrofitting make this an extremely challenging task.[241]

While most energy infrastructure in developed countries is already locked-in, the enormous expansion of power generation capacity in China offers a unique chance to make a real difference in future emissions levels. If it can be directed toward a more sustainable and low-carbon pathway, it *will* have a huge impact. However, the expansion is taking place at this moment, and if we want to make use of this chance, we should do it now. In a few decades this chance will have passed.

A similar argument holds for the housing boom in China. Construction of residential and commercial buildings is proceeding at a frenzied pace, fuelled by the ongoing urbanisation of rural citizens that still make up more than half of the Chinese population. Buildings account for about one-third of energy consumption in advanced economies via heating, cooling, lighting and other appliances, and it represents a field with a huge potential for emissions reduction in China as current building practices are still far behind international standards on average.[242] The measure of energy efficiency and insulation of all buildings being constructed now will determine the future energy consumption up to a large degree.

The latest key area is transportation, which has played only a minimal role in China's overall emissions up to now, but which will grow in importance due to its skyrocketing sales volumes, having had very limited market penetration before now. On a global level, emissions from transportation amount to almost one-quarter of total energy-related CO_2 emissions.[243] Improving the fuel efficiency standards of petroleum-fuelled vehicles, the

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[240] Recent installed capacity figures: 517 GW (2005), 623 GW (2006), 713 GW (2007), ca. 800 GW (2008). Steinfeld, Lester, Cunningham, *Greener Plants, Greyer Skies? A Report From the Frontlines of China's Energy Sector*, China Energy Group, MIT Industrial Performance Center, August 2008, p. 2.

Data: *China Electric Power Statistical Yearbook*, 2007; Caijing Magazine, 'China to Invest More in the Power Grid', 6 January 2009. Retrieved at http://english.caijing.com.cn/2009-01-06/110045381.html on 12 February 2009.

[241] Massachusetts Institute of Technology, *The Future of Coal,* 2007, p. ix.

[242] International Energy Agency, *Buildings and Community Systems (ECBCS)*. Retrieved at http://www.iea.org/textbase/techno/iaresults.asp?id_ia=12 on 12 May 2009.

[243] International Energy Agency, *World Energy Outlook 2008*, p. 392.

deployment of hybrid and electric cars and the development of alternative modes of transport can all have a significant impact on China's future emissions.

Yet the mitigation opportunities in these sectors are of a transitory nature. According to one report, a 5-year delay in starting to implement abatement technologies would result in a loss of one-third of the total abatement potential projected for 2030. Waiting 10 years before starting implementation, up to 60 percent of the potential could be lost.[244]

5.2 What can be expected from China at the Copenhagen meeting?

Given its perceived crucial role in the upcoming climate treaty negotiations, pressure has been building on China to give in to demands for strong commitments. Yet China has been very consistent in its negotiating position and has always maintained it will not commit to binding emission reduction targets.

China has made a strong case for this refusal and is employing a range of arguments to support its position. First, China emphasises its low contribution to historical cumulative emissions, arguing that it is the victim of climate change caused by the industrialised countries rather than the culprit. The industrialised countries should thus be held responsible for the problem and are the ones who should take action to solve it. Second, its per capita emissions are very low compared to those of developed countries, leading to the question of why Western citizens should have the right to more emissions per capita than the population in developing countries. Third, China is still a poor country with a low average per capita income and more than half of its population living in rural areas. As a developing country, poverty eradication is its top priority and it cannot be expected to prioritise climate change above economic development. Fourth, as the 'workshop of the world', a significant part of Chinese emissions is caused by the industrial production of commodities exported to the rest of the world. It would not be fair to hold China accountable for these emissions while the goods are consumed elsewhere. Fifth, China is already doing all it can to limit its greenhouse gas emissions. It has issued a *National Climate Change Programme* and its domestic policy includes ambitious targets in the fields of energy efficiency, afforestation and renewable energy development, which have received significant international acclaim. Following this reasoning, it would be inconceivable to expect more stringent commitments from a developing country such as China.

The international developments within the United Nations Framework Convention on Climate Change after the signing of the Kyoto Protocol in 1997 have offered China another strong card for staving off binding commitments. First of all, due to its classification as a developing non-Annex-I country, China could actively support the UNFCCC and the Kyoto Protocol objectives over the past decade without carrying the burden of emissions reduction commitments. Second, because of the refusal of the United States to ratify the Kyoto Protocol, the country can easily deflect criticism that as a major economic power and carbon emitter it should accept binding targets. Even if the Obama administration is able to muster enough domestic support for introducing strong domestic action on climate change, the Chinese would still have a point in arguing that

[244] McKinsey&Company, *China's Green Revolution*, 2009, p. 13. McKinsey Global Institute, *Fueling sustainable development: The energy productivity solution*, October 2008, pp. 4-5; International Energy Agency, *World Energy Outlook*, 2007, p. 51.

instead of taking the lead in mitigation efforts, the past 8 years in the United States have simply been characterised by policy inaction and emissions growth. Third, almost all of the countries that did agree to binding emissions reductions under Kyoto have had severe difficulties in meeting their targets, with some of them even giving up on the effort. According to the Chinese, the developed countries have not exactly shown the convincing leadership in tackling the problem that would oblige the developing countries to follow in the effort. Fourth, at previous climate treaty negotiations China has generally acted in concordance with the G-77 group of developing nations, in which it enjoys esteem as a shrewd negotiator. Being part of this group also serves the purpose of allowing China to avoid being singled out, making one of the major obstacles to a deal in Copenhagen the breaking down – or at least adjusting – of this configuration.

In general, it will be very hard to convince China to accept more commitments unless the dual system of Annex-I/non-Annex-I countries can be broken down and some kind of gradation can be introduced – but this promises to be a formidable task. The European Union and the United States have little sticks and carrots to offer in this respect, even fewer now that the financial and economic crisis is increasing China's leverage in global affairs. In the current situation, China can basically get away with not agreeing to any binding commitments without losing much.

Positive signs and openings to be explored

Nonetheless, there are also positive signs concerning the climate treaty negotiations and China's position. Overall, there has been an increasing awareness and acknowledgement of China's vital role in the problem, leading towards a more constructive approach from Chinese side. China has been supportive of the UNFCCC process and has engaged itself quite thoroughly in the climate change issue. It has become the largest player in the Clean Development Mechanism market, supplying more than half of all Certified Emission Reduction certificates traded worldwide. Even though this engagement may partly be explained by self-centred motives, such as concerns about energy security and environmental pollution, it has led to serious domestic initiatives which have deservedly gained international attention. Compared to the efforts in other countries, China has been bold in setting ambitious short- to medium-term targets, and sometimes even outpacing them, for instance in the development of renewable energy and nuclear power. It has also allowed the climate change issue to become a matter of extensive debate in society and politics, something that is not self-evident in a society in which the government has rather strong control over the media and a reputation to lose. On the contrary, China seems to have chosen this issue to enhance its domestic and international standing by showing that it is willing and able to take decisive action. The swift launching of China's *National Climate Change Programme* in the lead-up to the COP-13 Bali meeting can be seen as part of this strategy. It also fits into the country's foreign policy stance of portraying itself as a 'responsible stakeholder' in the global system.[245] Even though persuading China to take up stringent commitments will not be sufficient by itself, the prestige of being a deal-maker instead of a deal-breaker at this massively publicised international forum will certainly add an incentive for China to look for a possible compromise.

[245] D'Hooghe, I., *The Rise of China's Public Diplomacy,* Clingendael Diplomacy Paper, July 2007, pp. 17-19.

In the end, the domestic drivers aligned with the global mitigation objectives provide the best opening in the negotiations in terms of persuading China to do more. These drivers consist of the following: first, there is awareness that at a quite fundamental level, China's developmental pattern concerning energy consumption is not sustainable in the long term. Skyrocketing growth rates of consumption over the past decade, shortages of electricity due to a failure of power generation capacity to keep up shortly after 2000 and – more recently – transport fuel shortages due to high oil prices, have illustrated that China needs to make the switch to a more sustainable energy system in order to achieve its goal of economic development. In the long run, a huge population with increasing levels of energy consumption, combined with the worldwide gradual depletion of fossil fuels, also pleads a strong case for a timely switch to a low-carbon energy system. This problem resurfaces in the short term as the second driver: energy security concerns. Already China is saddled with a considerable dependency on oil imports – currently accounting for about half of its total oil consumption, but this is set to increase sharply. Gas imports are expected to follow the same pattern soon, and even the supply of coal might emerge as a problem, despite China's huge reserves. Strong policies on energy efficiency, demand reduction and switching to non-fossil energy sources address both energy security concerns and climate change mitigation goals, forming a powerful co-benefit solution. Third, attention for the environment is emerging as an increasingly important topic in Chinese politics. Although China has long prioritised economic growth at the cost of environmental degradation, public protest against this policy is gaining ground. Even though climate change is not yet widely perceived as an immediate threat domestically, air pollution is a major health problem in China. Addressing this problem not only cuts back on inefficient polluting coal-fired power plants and industry but also delivers gains for climate change mitigation. The final domestic driver pushing for a low-carbon energy system in China is economically motivated: China has expressed its ambition to develop its own world-class industry in renewable energy sources such as wind and solar power, nuclear power, electric and semi-electric cars and other low-carbon technologies. This is also part of China's strategy to transform its manufacturing and export industry from that of low-value to high-value added goods and incorporating into it more innovation, research and development of new technologies. These sectors are given preferential treatment in China in order to mature, but are expected to enter the globalised market as soon as they are competitive.

All of these drivers are pushing China in the direction of action that has the beneficial side-effect of lower greenhouse gas emissions. As such, these drivers should be encouraged and might be used to emphasise the self-interest that China has in transforming its energy system.

There are a few more paths that might yield some positive results in Copenhagen. For one thing, the Chinese government has already implemented a binding energy intensity target in its own most recent Five Year Plan. Under this plan, the energy intensity of the economy, i.e. the amount of energy consumed to produce one unit of gross domestic product, should fall by 20 percent in the five years leading up to 2010. Given the link between energy consumption and carbon dioxide emissions, this target could be easily translated into an *emission intensity* target, which would indicate the level of emissions associated with one unit of gross domestic product. In fact, this observation has been made by one of China's top officials on climate change as well. Such a target could be

chosen to entail a significant mitigation effort while not limiting Chinese economic growth in any manner. Moreover, it would be a measurable indicator and would circumvent the difficulty of forecasting the economic development and emissions growth of China, which would be necessary for establishing a business-as-usual scenario as a reference for mitigation achievements.

5.3 Focal points for a possible deal in Copenhagen with respect to China

Apart from the difficulty of agreeing to some sort of target for all parties involved, the negotiations on a possible deal in Copenhagen are expected to focus on the scope and implementation of the technology transfer and financing made available for mitigation and adaptation. Rules on these issues dealing with eligibility and the deployment of both technology transfer and financial incentives will shape the outcome of any possible deal as well as its potential effectiveness in spurring a global transition to low-carbon energy systems.

Since the exact content of an eventual final document will have to take into account the requirements of all parties, it cannot be expected to be tailored to Chinese needs. However, given the crucial role China has in mitigating climate change as sketched in the previous section, it would be worthwhile to outline the focal areas that should be addressed in China *specifically*, in order to maximise the impact. The following points follow from our previous analysis:

First, given the absolute dominance of coal in China's energy system, it being responsible for three-quarters of the country's carbon dioxide emissions, the key to influencing China's future emissions lies in dealing with China's coal consumption. This means trying to limit coal consumption as much as possible by reducing the energy demand growth and promoting other energy sources such as nuclear energy, renewable energy and other alternatives. To the extent that coal use cannot be avoided, it should be done in the best way possible, using the most efficient technology at hand. That means using highly efficient industrial furnaces, ultra-supercritical power plants and integrated gasification combined cycle technology as well as focusing on implementing carbon capture and storage (CCS) in the near future. A significant reduction of global greenhouse gas emissions by the mid-21st century cannot be achieved without the deployment of CCS in China. Given the high costs associated with retrofitting older plants, haste should be made in promoting CCS in China, along with coal gasification and IGCC technology. Necessary steps include the development of a Chinese standard on 'CCS-ready' power plants and including CCS considerations in power plant site allocation policy.

Second, international cooperation on a transformation of China's energy system should address China's energy security concerns. Insofar as China's energy security strategy is propelling it along the lines of a low-carbon development, it should be encouraged. These developments include, among others: the strong focus on energy efficiency and energy conservation, the fast expansion of nuclear energy, renewable energy sources and biofuels. However, parts of China's policy on energy security run counter to climate change objectives, such as the restriction on the use of natural gas for power generation due to future import concerns and the promotion of coal liquefaction technology. Fuel switching from coal to natural gas would be very much preferable given the rapid

expansion of China's power sector, but this will depend in part on the ongoing integration and accommodation of China in international gas markets. Coal liquefaction for transport fuels is an alternative which aggravates environmental degradation not only in terms of carbon emissions but also water scarcity.

Third, the Chinese government should be urged to strengthen its supervisory system on energy and environment. A persistent problem in China is that increasingly progressive legislation fails to have any impact due to ineffective implementation and enforcement. This holds true in particular for many laws on energy efficiency, such as building codes, power plants requirements, appliance labelling and vehicle fuel efficiency standards – all of which are instrumental in curbing Chinese energy consumption. Even though the 11th National People's Congress saw the establishment of a National Energy Administration at vice-ministerial level and a Ministry of Environmental Protection, the staffing and authority of these agencies are insufficient to be able to fulfil their tasks. Additionally, the perennial issue of ineffective enforcement of intellectual property rights is hampering technology transfer in the sense that many companies are unwilling to introduce their most advanced technologies in China, even if these technologies are very much needed from the perspective of climate change mitigation.

Fourth, China should be encouraged to accelerate the reform of its energy pricing system. The system of regulated prices for petroleum products and electricity is an impediment for progress on energy efficiency and has created severe market distortions in China in the past. A growing reliance on energy imports is forcing China to adjust its system, yet the government is still reluctant to remove energy subsidies and increase the financial burden upon its population. The current economic crisis actually offers a chance to make some structural adjustments to the pricing regime, as it has taken some pressure off the overheating Chinese energy sector and international oil prices. The goal should be to establish a sensible energy market which offers sufficient incentives for energy efficiency, with the eventual objective of implementing a price on carbon.

Fifth, mitigation activities in China could benefit greatly from the expansion of the Clean Development Mechanism, enhanced funding and technology transfer. China has already set up and streamlined its national CDM application procedures and has become the major player in the market for Certified Emission Reduction credits. CDM has played a role in developing the wind industry in China, and there are a few very promising areas for increased CDM involvement. One of the best examples is the utilisation of coal-bed and coal-mine methane: due to its large coal reserves China is also endowed with significant reserves of 'embedded' methane, a potent greenhouse gas which accounts for 12 percent of China's total emissions. Development of power generation capacity fuelled by these sources of methane would serve a double purpose: substituting coal-fired power and cutting back on emissions. Initial projects have started up under the CDM programme, but need to be scaled up significantly to have an impact.

5.4 But it will be very difficult to reach an agreement…

Despite the necessity for a global deal in Copenhagen on an effective global climate change regime and the urgency of the fleeting opportunity now available to China to mitigate emissions in the coming few decades, the chances of the negotiations failing is quite large, and the signs are not very auspicious.

First of all, the global financial and economic crisis has further worsened the prospects of reaching a conclusive agreement in Copenhagen. It has intensified the challenge of integrating action against climate change with sustainable economic development. Economic recovery has become a top priority worldwide, and in China itself the key role of economic development has only been further reinforced. The crisis has also made developed countries more reluctant to offer financial assistance to developing countries for climate change adaptation and mitigation. However, without such financial support, developing countries will surely not agree to any targets. Overcoming political opposition against significant financial contributions in Copenhagen will be an important step in the right direction. Defining targets and implementation methods in such a way that they will not hamper but rather stimulate economic recovery will be the crucial challenge for everyone involved.

Second, the Annex-I countries have a poor record in realising their commitments under the Kyoto Protocol. Of all countries included, only the European Union's EU-15 member states have a decent chance of achieving their target, while Russia and Eastern Europe are only well below their targets as a side-effect of their economic collapse. Japan, Canada and Switzerland are all not on track to meet their targets. The difficulties encountered have made many of them less enthusiastic about new stringent emissions targets, and up to now only the European Union has put forth legislation binding the Member States to reduce greenhouse gas emissions to at least 20 percent below 1990 levels by 2020.

A special role is of course taken up by the United States, which abandoned the Kyoto process in 2001 under President Bush but which experienced a major political turn-around on the issue after the election of President Obama. Yet despite campaign promises on a cap-and-trade system with full auctioning of emission permits and the ambition to tackle climate change globally, the United States might not be on the front line in the push for strict targets. This is partly due to domestic circumstances: a difficult health reform bill needs to be passed, and opposition from coal-dependent states limit the chances of a strong climate change bill coming into effect. The Waxman-Markey bill (enacted as the *American Clean Energy and Security Act*) has been watered down considerably, now representing a target roughly comparable to reaching 1990 emissions levels by 2020, but it still faces the tough challenge of passing in the Senate. Without domestic legislation, the United States will not be able to commit to strong targets in Copenhagen itself without running the risk of making the same misjudgement as it did in Kyoto. Second, after dismissing its Kyoto target of a 7 percent reduction by 2012, the United States has made no progress in curbing its emissions. Greenhouse gas emissions have grown by more than 14 percent since 1990, and reversing this growth by 2020 is already a very ambitious target.[246] Still, this is sure not to satisfy other Annex-I parties

[246] According to the UNFCCC U.S emissions in 2006 compared to 1990 went up with 14 percent (total GHGs), for CO_2 the figure stands at +17.7%. This is including emissions/removals from land use, land-use change and forestry.

who already participated in Kyoto. As China has already remarked, the new suggested target by the United States boils down to its original Kyoto commitment being delayed by about 20 years. [247]

The position of the United States makes it quite probable that it will aim for targets well short of the stringent targets proposed by the European Union (and the IPCC for that matter). Also Japan, the former ally of the E.U. on strict targets, is failing to meet its Kyoto target and has not been so enthusiastic about hard targets, although this might change with the newly elected government.[248] There is quite a strong possibility that the U.S. will engage in the climate treaty negotiations but steer it in a different direction than the E.U. is aiming towards. In particular, the American involvement in the climate treaty discussions is linked with the participation of China. One of the key arguments against the Kyoto Protocol voiced by the Bush administration was that it excluded China and India – with China being the most significant emitter. The Obama administration has made it clear that it wishes to engage China on this issue and cooperation on energy and climate change has risen to the top of their bilateral agenda, which was reaffirmed during the visit of Secretary of State Hillary Clinton to China in February 2009. As both countries are major oil importers and have a large share of coal in their fuel mix, cooperation on energy affairs would make much practical sense.[249]

There is actually a chance that the United States and China will be able to agree on some kind of reduction targets which would suit them both and, using this, push for a bilateral deal to try and dominate the negotiations in Copenhagen. In this way the United States might reclaim leadership on the issue and simultaneously get away with less stringent emission targets than Europe proposes, while letting China share in the prestige as well. Since China and the United States together account for almost half of all greenhouse gas emissions, an agreement between them would be hard to overturn by the remaining parties.

On the other hand, it is even more probable that China and the United States will disagree, in particular about the targets that both countries should commit to. As was mentioned earlier, the system of Annex-I and non-Annex-I countries would need to be broken down or adjusted if China would accept some kind of binding targets. Yet this gradation is a very touchy subject in the negotiations since it would turn the whole system into a sliding scale. The position of India is of particular relevance. If China is to undertake any kind of commitments, it will insist that India will have to do so as well. The United States has previously mentioned India as one of the major emitters that

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Excluding these emissions/removals the figures are +14.4% for all GHGs and +18.1% for CO_2 emissions. UNFCCC, *National greenhouse gas inventory data for the period 1990-2006 (FCCC/SBI/2008/12),* 17 November 2008. Retrieved at http://unfccc.int/resource/docs/2008/sbi/eng/12.pdf on 15 February 2009.

[247] *Euractiv,* 'China chides rich countries' low climate ambitions', 9 June 2009. Retrieved on 10 June 2009 at http://www.euractiv.com/en/climate-change/china-chides-rich-countries-low-climate-ambitions/article-183024.

[248] The election victory of the Democratic Party of Japan in August 2009 has raised hopes on more ambitious commitments by Japan, as it vowed to reduce greenhouse gas emissions in 2020 by 25 percent compared to 1990 levels. Yet strong opposition from industry and business associations make it uncertain if this target can be made into legislation. Moreover, this target is also conditional upon sufficient commitments by India and China. Luta, A., *Climate Sudoku. Japan's Bumpy Ride Towards a Post-2012 Target,* The Finnish Institute of International Affairs, Briefing Paper 36, 24 June 2009; *Reuters,* 'Japan emissions target hinges on international deal', 4 September 2009.

[249] For a discussion of such U.S.-China cooperation see: Asia Society/Pew Center on Global Climate Change, *A Roadmap for U.S.-Chjina Cooperation on Energy and Climate Change*, January 2009; Lieberthal, K. and Sandalow, D., *Overcoming Obstacles to U.S.-China Cooperation on Climate Change*, The Brookings Institution, 2008.

should be included in the Kyoto process in order to make it effective. Yet India, which emits about 4 percent of the world's greenhouse gases, is even more principled in its negotiations than China and less willing to compromise. Hence it could act as the perfect scapegoat for China to blame if the negotiations were to fail on this point.

Moreover, there are still other parties to take into account. Russia and the Middle Eastern countries will be extremely difficult to get on board. As their emissions are high and rising quickly, they form an important part of the deal to make it work. However, their interest in mitigating emissions is very limited as they will lose export markets for their hydrocarbon resources. Furthermore, global warming might be a positive development for Russia. The chances of seducing Russia with some bartering, for example the exchange of the Kyoto Protocol for support with its WTO accession, are small and such a deal is unlikely to be repeated again.

Quite possibly, only a framework agreement or some sort of partial deal will come out of Copenhagen. If a partial deal would emerge, with some countries agreeing on stringent targets but others not participating 'enough', there might be thorny consequences. One of the fears is that of the instigation of a carbon import tariff on goods imported from parties that refused to commit to strict targets, which has already been proposed in the United States. This type of protectionism to address the 'carbon leakage' issue could have serious negative consequences for global trade, all the more since protectionism has already been on the rise due to the financial and economic crisis and national concerns about unemployment.

What is left in the case of failing negotiations is of course even more negotiations and an even longer delay before action is taken on climate change. This would mean that valuable mitigation opportunities will slip away, especially in rapidly developing countries like China. If the global community wants to make use of the chances that China is offering and steer its development in a more sustainable direction, it is imperative that it acts now.

List of Abbreviations and Acronyms

bcm	billion cubic metres
BP	British Petroleum
CCS	carbon capture and storage
CNCCP	China's National Climate Change Programme
CNOOC	China National Offshore Oil Corporation
CNPC	China National Petroleum Corporation
CO_2e	carbon dioxide equivalent
COP	Conference of the Parties
EIA	Energy Information Administration, U.S. Department of Energy
EU	European Union
FDI	Foreign Direct Investment
GDP	gross domestic product
Gt	gigatonnes (metric)
GW	gigawatt
IEA	International Energy Agency
IGCC	integrated gasification combined cycle
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
mtoe	million (metric) tonnes of oil equivalent
MW	megawatt
NDRC	National Development and Reform Commission, China
NEA	National Energy Administration, China
OECD	Organisation for Economic Co-operation and Development
ppm	parts per million
PPP	purchasing power parity
tce	(metric) tonnes of coal equivalent
tcm	trillion cubic metres
tonne(s)	metric tonne(s)
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WEO	World Energy Outlook [IEA publication]
WRI	World Resources Institute
WTO	World Trade Organisation

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