9. China's Climate and Energy Policy:
On Track to Low-carbon Growth?

Frank Jotzo and Fei Teng[1]

Introduction

China has become the world's largest emitter of greenhouse gases, and in many ways is the linchpin of global climate change policy. If China's coal use and carbon dioxide emissions keep growing alongside GDP then current global goals for limiting climate change will be out of reach. If, however, China manages to decouple its emissions trajectory from its economic growth then ambitious global emissions reductions scenarios remain feasible, and other industrialising countries may be inclined to emulate China's pathway.

For China's policymakers, climate policy goes hand in hand with other objectives, including reducing local air pollution, improving energy security and attaining a leadership position in advanced manufacturing technologies. The various targets to 2020 for emissions, energy use and energy technologies reflect this. China appears on track to achieving these, but action commensurate with strong global climate change mitigation during the following decade will require ongoing and strengthening policy effort.

China's climate change policy is intricately linked to two fundamental aspects of China's economic trajectory. First, macro-economic 'rebalancing', less rapid GDP growth and ongoing structural change in China's economy could facilitate a marked slowdown in the growth rate of energy demand, and hence carbon dioxide emissions.

Second, continuing the drive for market reform in China's economy, as the new leadership seems intent on, can help China achieve emissions reductions at lower economic cost. Putting a price on carbon emissions—by way of emissions trading or a carbon tax—can be more cost-effective than the command-and-control approach that has been dominant until now. To function well, however, this will require market reform in China's energy sector. Climate policy is thus part of the broader picture of economic and market reform in China.

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It is now widely accepted that market mechanisms should play a key role in long-term climate policy in China, with seven regional emissions trading schemes a highly visible statement of policy intent.

In this chapter, we provide an update on China's emissions trends and its trajectory towards the 2020 emissions intensity target; an overview of China's moves to market-based climate change mitigation policies with a brief discussion of the seven emissions trading pilot schemes, most of which have recently come into operation; and a discussion of the need for reform in China's energy policy to make market instruments for climate change policy effective.

China's energy use and emissions: an update

China in international comparison

China overtook the United States as the largest emitter of carbon dioxide in 2006 (IEA 2013a). In 2011, China accounted for 21 per cent of global energy demand, 49 per cent of global coal use by energy content and 26 per cent of global energy-related carbon dioxide emissions (IEA 2013b; see Figure 9.1). China's per capita emissions have risen above the world average and are almost as high as those in the EU average, though still little higher than one-third of per capita emissions in the United States, Canada and Australia.

The primary reason for the rise in China's emissions has been China's very rapid economic growth, which has come with very rapid increases in energy use, and the bulk of the additional energy used is supplied from fossil fuels, in particular coal—the most carbon-intensive fuel.

China's challenge, and opportunity, in reining in emissions growth is the relatively high emissions intensity of its economy (Table 9.1). China's carbon dioxide output for every dollar of GDP, adjusted for purchasing power in 2011, was twice that of the United States and three times that of Europe. The ratios are 4.5:1 and about 7:1 when measuring GDP at exchange rates.[2]

The comparatively high emissions intensity of China's economy is primarily due to a comparatively high amount of energy used per unit of GDP, and also because of a relatively high amount of carbon dioxide per unit of energy used.

2 GDP at exchange rates is usually not a suitable measure for comparison across economies, but is relevant for the traded commodity sectors of the economy, including heavy industries, which are important in China's emissions profile.

The reasons for high energy intensity are found partly in China's economic structure, with a relatively high share of economic activity in heavy industries, supplying the rapid expansion of domestic infrastructure as well as exports, and partly in relatively low energy efficiency in many (though not all) industries and processes.

Both aspects provide great potential for improvement of China's energy intensity. China's infrastructure investment boom is slowing and the investment ratio in GDP is expected to fall, and it is likely the composition of China's exports will continue evolving to higher-value manufacturing.

Ongoing modernisation of industrial production facilities steadily improves the average technical energy efficiency of production in areas such as electricity generation (where new coal-fired power plants are typically of very high energy efficiency), steel production, chemical manufacturing and other industrial activities. There is also large scope for improvements in the energy efficiency of buildings and cars.

The relatively high emissions intensity of China's energy supply—around 20 per cent above US and global levels, and 36 per cent above average EU levels—is primarily due to the dominance of coal in China's energy supply. As discussed below, it is a Chinese policy objective to reduce the share of coal in the energy supply, with resulting reductions in the carbon intensity of the energy system.

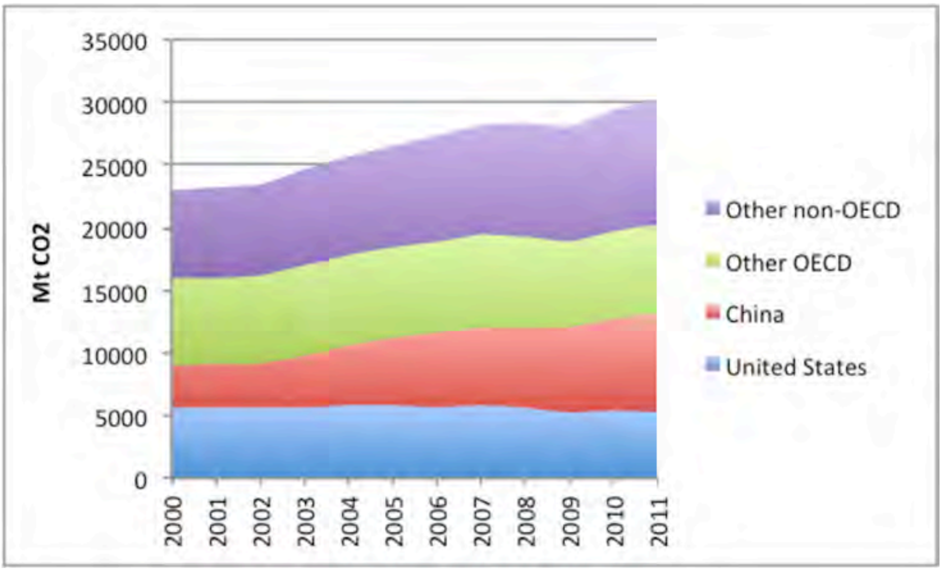

Figure 9.1 Global Carbon Dioxide Emissions

Source: IEA (2013a).

Note: Emissions of carbon dioxide from fossil fuel combustion.

Table 9.1 Emissions and Energy Intensity, Selected Countries and Regions, 2011

	Emissions per capita	Emissions intensity of the economy		Energy intensity of the economy		Emissions intensity of energy supply
	CO_2 emissions/ population (t CO_2 / capita)	CO_2 emissions/ GDP using purchasing power parity	CO_2 emissions/ GDP using exchange rates	Total primary energy supply/ GDP using purchasing power parity	Total primary energy supply/GDP using exchange rates	CO_2 emissions/ total primary energy supply (t CO_2/ terajoule)
		(t CO_2/US$'000 [2005 prices])		(petajoules/US$ billion [2005 prices])		
China	5.9	0.78	1.81	11.2	25.9	69.7
United States	16.9	0.40	0.40	6.9	6.9	57.6
European Union—27	7.0	0.25	0.24	4.9	4.7	51.2
OECD average	9.9	0.33	0.32	5.9	5.8	55.6
Non-OECD average	3.1	0.55	1.26	9.6	21.9	57.4
World	4.5	0.45	0.60	7.8	10.5	57.1

Source: IEA (2013a).

Trends in energy use, composition and carbon dioxide emissions

China's energy consumption grew by 8 per cent per year on average over the decade to 2011. Preliminary data for 2012 and 2013, however, indicate that growth in energy consumption is slowing, and that consumption of coal—the most carbon-intensive fuel—has been growing more slowly than energy consumption overall in the past two years (Table 9.2). As a result of slower GDP growth and also a greater rate of reduction in energy intensity of GDP, carbon dioxide emissions growth has slowed, although annual growth rates are still high compared with most other countries. The carbon intensity of energy supply has remained almost unchanged. According to our calculations, the emissions intensity of GDP fell by 3.9 per cent and 3.5 per cent during 2012 and 2013, respectively.

A caveat is in order on the data for 2012 and 2013. Our calculations in Table 9.2 rely on 2012 and 2013 growth rates for consumption of each fossil fuel, as reported in the *Statistical Communiqué of the People's Republic of China* (NBS various years), and data for earlier years as reported by the International Energy Agency (IEA 2013a). Emissions levels for 2012 and 2013 are inferred by grafting data for growth in energy use by fuel onto IEA data of carbon dioxide emission by fuel in 2011. The data in the *Statistical Communiqué* are often later revised in the *Statistical Yearbook*, which is considered a more authoritative data source.

No official Chinese data for carbon dioxide emissions levels are available, and internationally accepted data for emissions (for example, by the IEA) are available only to 2011. There has been, however, a recent official communication that emissions intensity fell by 10.7 per cent from 2010 to 2013, and energy intensity by 9 per cent. These official data for the period 2010–13 are reflected in Table 9.4; the data in Table 9.2 have the same underpinning features but do not match the official statement.

Looking at preliminary statistics for energy use by fuel reveals that the slowdown in emissions growth is mostly due to a deceleration in the growth of coal use. The annual average increase in coal use was around 8 per cent during the period 2005–11; according to preliminary data for 2012 and 2013, it slowed to around just 3 per cent per year during these past two years (Table 9.3). Coal accounted for 83 per cent of China's fossil fuel emissions during 2011, oil for 14 per cent and gas for 3 per cent (IEA 2013a).

The year 2012 was unusual in that there was an unusually large amount of hydroelectricity available due to heavy rains, and nuclear power plants came back online after temporary shutdown in the wake of the Fukushima nuclear accident in Japan. The fact that coal-use growth did not jump back to historical levels during 2013 indicates, however, that a more permanent effect might be at play.

A much discussed question is whether this slowdown in coal demand growth is a one-off or whether it is a permanent feature, which might lead to a stabilisation of absolute levels of coal used in the Chinese economy, and eventually a decline. This is discussed further below.

Table 9.2 Growth Rates in GDP, Energy Use, Carbon Dioxide Emissions and Intensities, China (per cent)

	Real GDP	Energy consumption	Carbon dioxide emissions	Emissions intensity of GDP	Energy intensity of GDP	Carbon intensity of energy
2005	10.4	10.6	11.7	1.2	0.1	1.0
2006	12.7	9.6	9.4	−2.9	−2.7	−0.1
2007	14.2	8.4	6.8	−6.5	−5.0	−1.5
2008	9.6	3.9	2.7	−6.3	−5.2	−1.1
2009	9.2	5.2	4.7	−4.1	−3.6	−0.5
2010	10.4	6.0	6.8	−3.3	−4.0	0.8
2011	9.3	7.0	9.7	0.3	−2.1	2.5
2012[a]	7.7	3.9	3.5	−3.9	−3.5	−0.3
2013[a]	7.7	3.7	4.0	−3.5	−3.7	0.3
2005−11 average	10.8	7.2	7.4	−3.1	−3.2	0.1
2012−13 average[a]	7.7	3.8	3.8	−3.7	−3.6	0.0

[a] Emissions and emissions intensity data for 2012 and 2013 are our approximations on the basis of data described below.

Sources: GDP and energy consumption for 2005–11 are from *China Energy Statistical Yearbook* (NBS 2011); growth rates for 2012 and 2013 are from *Statistical Communiqué of the People's Republic of China* (NBS various years), with data subject to revision; carbon dioxide emissions between 2005 and 2011 are from IEA (2013a); carbon dioxide emissions growth rates for 2012 and 2013 are inferred by applying the 2012 and 2013 growth rates for the use of coal, oil and gas (see Table 9.3) to the 2011 emissions data by fuel in IEA (2013a), and aggregating. See text for caveats.

Table 9.3 Growth Rates in Fossil Fuel Energy Use, China (per cent)

	Total energy consumption	Coal consumption	Oil consumption	Gas consumption
2005	10.6	10.6	2.1	20.6
2006	9.6	9.6	7.1	19.9
2007	8.4	7.9	6.3	19.9
2008	3.9	3.0	5.1	10.1
2009	5.2	9.2	7.1	9.1
2010	6.0	5.3	12.9	18.2
2011	7.0	9.7	2.7	12.0
2012	3.9	2.5	6.0	10.2
2013	3.7	3.7	3.4	13.0
2005–11 average	7.2	7.9	6.1	15.6
2012–13 average	3.8	3.1	4.7	11.6

Sources: Total energy consumption for 2005–11 are from *China Energy Statistical Yearbook* (NBS 2011); growth rates for 2012 and 2013 are from *Statistical Communiqué of the People's Republic of China* (NBS various years), with data subject to revision.

Emissions intensity targets

China has framed its aggregate goals for energy use and emissions in terms of the energy intensity and emissions intensity of the economy—that is, the amount of energy used and carbon dioxide emissions produced per unit of GDP.

China has a national target to reduce the emissions intensity of the economy (the ratio of carbon dioxide emissions to GDP) by 40 to 45 per cent from 2005 to 2020. The 45 per cent target will require an annual average reduction in emissions intensity of 3.9 per cent over that 15-year period. The target is expected to require significant efforts compared with a business-as-usual scenario (Stern and Jotzo 2010; McKibbin et al. 2011). There are also intensity targets in place for the five-year periods of the Eleventh and Twelfth Five-Year Plans (Table 9.4).

Emissions intensity targets are unusual in the international context, where most developed countries have adopted absolute emissions reductions targets. An emissions intensity target, however, is a relevant way of framing the policy goal. It addresses directly the key concern of climate change mitigation policy, which is to decarbonise economic activity, irrespective of the rate of economic growth. An emissions intensity target can also act as an automatic adjustment if GDP growth is volatile. It guards against overly large required emissions reduction efforts if GDP growth turns out to be very high, and ensures greater absolute emissions reductions than an absolute target if GDP growth is lower than expected (Jotzo and Pezzey 2007).

Both the energy intensity and the emissions intensity of the economy declined by 26 per cent from 2005 to 2013 (data and caveats as per Table 9.2), while carbon dioxide emissions per unit of energy (carbon intensity of energy) have remained stable. The reduction in energy intensity of the economy derives from two effects: first, improved energy efficiency—for example, through deployment of more energy-efficient power stations, industrial installations and cars; and second, as the result of changes in the composition of the economy, with lower energy-using sectors contributing a growing share of GDP.

Table 9.4 Emissions Intensity and Energy Intensity Targets and Performance (per cent)

	Emissions intensity change (ratio of carbon dioxide emissions to GDP)		Energy intensity change (ratio of total primary energy demand to GDP)		Carbon intensity change (ratio of emissions to energy demand)
	Target	Actual	Target	Actual	Actual
2005–10	n.a.	−21	−20	−19	−3
2010–13	n.a.	−10.7	n.a.	−9	−1.7
2010–15	−17	..	−16		..
2005–20	−40 to −45	..	n.a.	..	..

n.a. = not applicable

.. = not available

Sources: Actuals for 2005–10 from IEA (2013a) and for 2010–13 from Xinhua (2014); targets from Lewis (2011).

Outlook for emissions intensity

Given the rapid changes in the nature of China's economic growth and the dynamic policy environment, it is difficult to make predictions about the future trajectory of emissions intensity. However, some factors can be identified.

First, it may be that improvements in technical energy efficiency are becoming more difficult to achieve, as the low-hanging fruits such as replacing inefficient and outdated plants with new technology have been implemented.

Second, it is an open question as to what extent continued change in the composition of the economy can drive further reductions in energy intensity. It could be that structural change will become a more important driver of reductions in emissions intensity, and remain so for a long time. This question is crucial for China's longer-term emissions trajectory.

Third, reductions in the carbon intensity of its energy supply could play a greater role in future, especially if the rate of energy demand growth tails off. Together with increasing policy effort to dampen coal use, it is plausible that we will see a greater share of renewable energy sources such as wind and solar power as well as hydroelectricity, and also an increasing share of nuclear power in the overall energy mix.

A greater role for natural gas in the power system and industry—displacing coal, which is roughly twice as carbon intensive per unit of energy—may also assist. China does not, however, have large conventional gas deposits—it remains unclear to what extent shale gas can be exploited in China—and there are limits to reliance on large-scale importing of gas, which comes via pipeline from Russia or Central Asia, or by ship in the form of liquefied natural gas.

In the longer term, carbon capture and storage from fossil fuel-fired power stations and industrial installations are potentially an option to drastically reduce the carbon intensity of the energy system. The technology to date, however, is applied globally only in a small number of industrial installations and not in large-scale power stations. Just as importantly, applying carbon capture and storage is expected to remain costly.

What does China's 2020 emissions intensity target imply?

The 26 per cent decline in emissions intensity from 2005 to 2013 is broadly on the trajectory to achieve the target of a 40–45 per cent reduction from 2005 to 2020.

The dominant view in the expert community is that the 2020 target will be achieved. A survey of China-based experts (Jotzo et al. 2013) indicated strong confidence that the existing 2020 target will be achieved or surpassed. Of respondents, 87 per cent stated that they expect China will achieve or surpass its emissions intensity target; among them one-third believes the target will be surpassed.

What does the intensity target mean for absolute emissions levels? As long as GDP growth rates are above the targeted rates of decarbonisation then absolute emissions can continue to increase; however, a slowdown in economic growth rates would curtail the 'allowable' absolute amount of carbon dioxide emissions considerably.

The intensity target can be translated into absolute emissions levels by combining data for 2005–13 with an assumed rate of GDP growth from 2014 to 2020. The official target GDP growth rate for 2014 is 7.5 per cent. Huang et al. (2013) see China's growth potential for the current decade at 6–8 per cent per year. It follows that any disruptions to the growth experience could result in significantly lower GDP growth than the 7 per cent annual growth often used as a default assumption, though faster growth is of course also possible.

Assume, for illustration, annual average GDP growth for the remainder of the decade of 8 per cent per year as a 'high' case and 5 per cent as a 'low' case. The latter would be considered very low indeed, and in previous years such 'slow' growth scenarios have often been seen as unrealistic, however, signs are emerging that Chinese GDP growth is moderating, and that the Chinese Government may prioritise the quality of growth over maximising the rate of economic expansion.

If GDP were to grow at an average annual rate of 8 per cent between 2014 and 2020 then reducing emissions intensity by 45 per cent over the period 2005–20 implies that absolute emissions in China may increase by 29 per cent from 2013 levels to 2020 (Table 9.5).

In contrast, if GDP were to grow at an average rate of only 5 per cent per year during 2014–20, the same intensity target implies an increase in emissions of only 6 per cent over 2013 levels, or by 15 per cent for the less stringent emissions intensity target, over the remainder of the decade. Under such a low growth scenario, current trends in emissions would see the remaining 'headroom' for emissions growth well before 2020.

Table 9.5 'Allowable' Total Increases in Emissions between 2013 and 2020 for Different Scenarios of GDP Growth and Different Reductions in Emissions Intensity from 2005 to 2020

	40% reduction target	45% reduction target
5% GDP growth	15%	6%
8% GDP growth	40%	29%

Sources: GDP and energy consumption for 2005–11 are from *China Energy Statistical Yearbook* (NBS 2011); growth rates for 2012 and 2013 are from *Statistical Communiqué of the People's Republic of China* (NBS various years), with data subject to revision; carbon dioxide emissions between 2005 and 2011 are from IEA (2013a); carbon dioxide emissions growth rates for 2012 and 2013 are approximated by applying the 2012 and 2013 growth rates for the use of coal, oil and gas (see Table 9.3) to the 2011 emissions data by fuel in IEA (2013a), and aggregating.

Note: For the purposes of this calculation, 2013 carbon dioxide levels are 58 per cent above 2005 levels, and 2013 GDP levels are 116 per cent above 2005 levels.

Post-2020 trajectories and targets

China, along with all other major countries, is expected to submit a target for its emissions for the period 2020–25 or 2020–30, as part of the preparations for a new international climate change agreement aimed for at the UN climate conference at the end of 2015. Termed 'intended nationally determined contributions', these targets are not expected to be legally binding.

China has given no official indications of the nature and stringency of a post-2020 emissions target. There has been speculation that China might take on a target for absolute emissions levels rather than an intensity target. In a survey of experts (Jotzo et al. 2013), around 40 per cent of respondents expected an absolute target to be in place by 2025, and around 70 per cent by 2030. But it should be noted that such an absolute target might not be an absolute *reduction* target—it could provide a ceiling for China's emissions in the post-2020 period but still allow for moderate increases and then a peak and decline.

An increasing amount of quantitative analysis revolves around the question of when China's emissions will peak, and at what level.

As an illustration of the wide range of trajectories considered by analysts, see the three core scenarios produced by the IEA's *World Energy Outlook* (IEA 2013b) in Figure 9.2. Under the specific assumptions made by the IEA, continuation of current policies would see China's national emissions increasing until after the 2035 projection horizon; a scenario with new, additional policies would have emissions levels flattening out by 2030, at levels about 20 per cent below those in the 'current policy' scenario and about a quarter above current levels. A trajectory compatible with the globally shared ambition of limiting global warming to 2°—the so-called '450 scenario'—would see China's emissions falling drastically through the 2020s and beyond, to levels around half present levels by 2035.

Few analysts consider a scenario of early peaking in emissions followed by rapid reductions likely; however, as shown in technical analyses (for example, Jiang et al. 2013), China's carbon emissions could peak in the next decade, if options for energy efficiency and fuel switching are pursued across the economy and shifts occur in the patterns of production and consumption.

The peaking of China's emissions is also closely linked with the unknown future of China's economic growth. China's GDP growth in the past three decades has been about 10 per cent per year and the annual reduction rate of emissions intensity has been in the order of 4.5 per cent per year. Therefore, China's emissions have increased by about 5–5.5 per cent annually on average in past decades. If China can maintain this trend to reduce its emissions intensity, it can peak its emissions when the GDP growth rate falls from the current 8 per cent range to about 5 per cent per year.

So the fundamental question is twofold: when China's GDP growth rate will fall to a level equal to the rate of emissions intensity reduction; and whether there will be a more ambitious policy that can further improve the annual emissions intensity to achieve a peak in China's emissions at relatively high GDP growth rates.

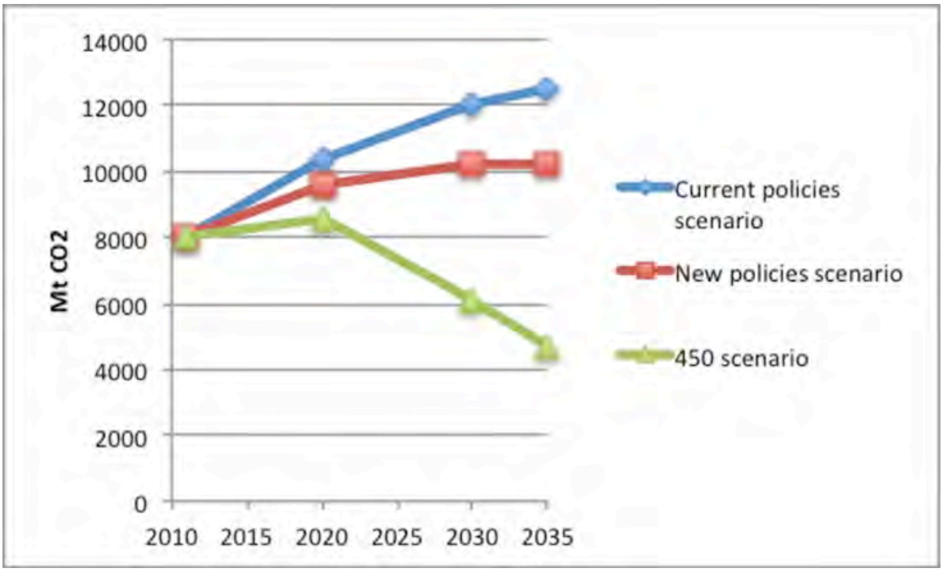

Figure 9.2 IEA Scenarios for China's Future National Emissions Levels
Source: IEA (2013b).

Challenges in China's energy sector

Current challenge in energy sectors

Adjusting the economic structure is necessary to develop China's economy since economic development is confronted with the prerequisite of energy constraints. The energy system in China faces many problems, among which are three prominent ones: the difficulties in the adjustment of energy structure, the dilemma of fossil fuel energy's growth, and pressure from the ever-increasing dependence on foreign energy.

Adjustment of energy structure

China is currently in the period of industrialisation with the total energy demand growing continuously. Although new and renewable energy sources have developed rapidly in recent years, the proportion in the total energy supply is still relatively low, and increases in renewable energy capacity have not been meeting the increases in demand.

Growth of the total amount of fossil fuel energy

Despite the rapid development of renewable energy and various energy-saving measures, rapid growth in energy demand leads to the growing consumption of coal, oil and other fossil fuel energies. While the growth rate is lower, the growth of fossil fuel energy has caused serious environmental problems, which have drawn more and more attention. The lingering thick smog and hazy weather in Beijing, Tianjin and Hebei provinces—namely, the problem of particulate matter (PM) 2.5 exceeding health standards—are mainly caused by coal combustion and vehicle exhaust emissions. Thus in order to solve environmental problems fundamentally, the structure of energy must be changed and the total amount of coal consumption must be controlled. Beijing, Tianjin and Hebei have now developed goals to control coal consumption.

Continuous rise of dependence on foreign energy

With growing energy demand, China's energy has increasingly depended on foreign sources. It is estimated that the proportion of imported oil will reach 70 per cent and natural gas 50 per cent by 2020, so dependence on overseas sources makes energy security an important focus of policy. Since the international environment is peaceful, energy supplies are unlikely to be interrupted; however, emergencies in some regions and geopolitical factors may cause a temporary shortage of supply and price fluctuations, which introduce risk to the stable operation of the economy.

Therefore, how to balance energy security, increase the supply of energy and solve the environmental problems are significant challenges for the energy system in China.

An energy strategy to manage demand

Ensuring energy supply has long been the main consideration in China's energy strategy. The level of supply accords with the demands of national economic and social development. Currently in China, however, especially in the context of climate change, reducing the consumption of fossil fuel energy is an important objective. The aim of China's energy strategy is not only to ensure supply, but also to adjust and guide demand, using policy to regulate and control requirements,.

China has proposed 'to promote the transformation of energy production and utilisation' in the Twelfth Five-Year Plan, which means improving energy efficiency, to plan energy production and to make the transition to renewable and clean energy.

The report of the Eighteenth CPC National Congress further highlighted this issue and altered the proposal from 'transformation of energy production and utilisation' to 'revolution of energy production and consumption'. There are two key changes. One is replacing 'utilisation' by 'consumption'. The emphasis on energy consumption reflects the desire to reduce unreasonable or adjustable energy demands. Replacing 'transformation' with 'revolution' means changing the energy system in a more intense and thorough way in order to adapt to the needs of economic and social development.

Phasing out coal

Fast-growing coal consumption in China has led to various problems. First, coal has been considered a domestic and safe recourse, but China has become a net coal importer since 2010, which poses an additional challenge to China's energy security concerns. Second, coalmining and consumption have added to acute local environmental issues. Substantial coalmining and consumption consume a large amount of water, and lead to slag penetration and deposition, resulting in the serious pollution of groundwater resources. In addition, coalmining can cause the collapse of surface areas that have been mined out underneath. Areas of subsidence in China have reached 10 000 sq km. Furthermore, the burning of coal is to a considerable degree responsible for conventional pollutants such as sulfur dioxide, nitrogen oxide and dust, including thick smog and haze such as that experienced in Beijing and Tianjin. Last but not least, coal combustion contributes a major share of China's carbon emissions.

Therefore, a cap on coal consumption is now widely seen as essential for China to address the combination of policy concerns. Although the policy road map to phase out coal is still not clear in China, the consensus is emerging from research communities that a coal cap is essential in the near term, driven above all by concerns about air quality.

Policy instruments and objectives

China's new leadership has reiterated the country's ambition to limit the growth in energy consumption and carbon dioxide emissions. President Xi Jinping remarked in a recent speech (The Economist 2013) that China's current growth pattern is 'unbalanced, uncoordinated and unsustainable', and China should pursue a new mode of growth to promote 'more efficient, equal and sustainable economic development'.

A host of regulatory interventions to improve energy efficiency and reduce the carbon intensity of China's energy system is already in place.

The new development is that market-based instruments for emissions control are likely to come into play, in the form of emissions trading pilot schemes and preparations for a national carbon emissions trading scheme, or possibly a carbon tax.

It is well-established that putting a price on emissions—by way of a carbon tax or emissions trading—is the most cost-effective policy approach to achieve broad-based emissions control. Direct regulation and subsidy approaches are suitable in specific instances, but are inferior if used as the sole policy instruments.

For carbon pricing to be effective, however, a number of prerequisites need to be in place. First among them is the operation of markets in relevant parts of the economy, allowing the price signal from a tax or emissions trading to determine incentives, and ultimately to influence the investment and consumption decisions of companies and individuals. In China, these prerequisites are not yet generally provided (Howes and Dobes 2010; Baron et al 2012).

Emissions trading pilot schemes

Seven pilot emissions trading schemes have been developed, with six operational at the time of writing in April 2014. In 2010 the seven pilot cities and provinces accounted for around 19 per cent of China's population, 33 per cent of its GDP, 20 per cent of its energy use and 16 per cent of its carbon dioxide emissions (Table 9.6).

The emissions trading pilot schemes cover only part of the total emissions in each city or province, but combined will be second in size only to the European emissions trading scheme, and much larger than the Australian and Californian schemes.

The pilots differ in important design features, reflecting diverse settings and priorities (Zhang et al. forthcoming; Qi and Wang 2013; Zhang 2013). They are set to provide a laboratory for gathering experience with different designs and implementation methods, and the effect of emissions pricing in different economic settings, encompassing fast-growing provinces heavily dependent on heavy industries, such as Hubei, through to advanced cities where services and high-value manufacturing dominate, such as Beijing, Shanghai and Shenzhen.

Table 9.6 Indicators for Pilot Provinces and Cities, 2010

	Population (million)	GDP (RMB billion)	GDP per capita (RMB '000)	Energy use (million t SCE)	Energy use per capita (t SCE/capita)	Carbon dioxide emissions (million t)	Emissions per capita (t CO_2/capita/year)	Emissions intensity (kg CO_2/RMB)
Shenzhen SEZ	10	903	87	49	4.7	n.a.	n.a.	n.a.
Beijing	20	1182	60	70	3.5	103	5.2	87
Tianjin	13	781	60	68	5.3	134	10.3	172
Shanghai	23	1556	68	112	4.9	211	9.2	136
Chongqing	29	616	21	79	2.7	125	4.3	203
Hubei	57	1250	22	151	2.6	320	5.6	256
Guangdong	104	4016	39	269	2.6	444	4.3	110
China	1341	31 234	23	3895	2.9	8146	6.1	261
Pilot schemes combined	256	10 303	40	798	3.5	1337	5.2	130

n.a. = not applicable

SCE = standard coal equivalent

Sources: *China Statistical Yearbook* (NBS various years); Guan et al. (2012) for emissions data (emissions data are not published as part of official Chinese statistics); authors' calculations.

A national emissions trading scheme?

China has stated its intention to establish a national emissions trading scheme in the future, as a central part of its climate change and energy strategy. This was first mentioned in the Twelfth Five-Year Plan (see Zhang et al. forthcoming for a chronology).

Originally, a national scheme was planned to start in 2015 or 2016. This timeline now appears unrealistic. In recent official communications no timeline has been given for the introduction of a national emissions trading scheme. The expert community, however, expects that a national scheme may be introduced by around 2020, coinciding with the Fourteenth Five-Year Plan and China's post-2020 emissions target period.

A blueprint for the design effort towards a national emissions trading scheme (NDRC 2013) identifies key areas for further analysis. This document foreshadows a scheme that might broadly resemble the approach taken in the EU emissions trading scheme, but might also take into account specific features of the Australian and Californian schemes, and making important modifications to cater to specific circumstances in China. The document emphasises the need for analysis and careful scheme design in the electricity sector, and as it applies to state-owned enterprises. It also raises practical issues of developing reliable company-level measurement, reporting and verification of emissions.

Policy objectives

The targets and steps for policy innovation need to be seen in the context of a broader vision of 'green growth', with emphasis on the quality of economic growth. This would see a reorientation of economic expansion to activities that place little stress on the natural environment—for example, advanced information networks and low-carbon transport systems, as well as health, education and other services—in preference to continued expansion of material-intensive growth structures (Zhang and Brandon 2012). The enveloping concept is that of 'ecological civilisation', embraced by the CCP at the Seventeenth National Congress, which has nature 'as part of our life rather than something we can exploit without restraint', and places emphasis on social justice and fairness in development (China Daily 2007).

China is still a long way from changing its growth model to a 'green' model, and resource-intensive, polluting and socially inequitable economic expansion can be expected to continue for a long time: 'brown' dominates 'green' growth and in most areas will continue to do so for some time.

There are important reasons why the Chinese leadership would pursue green objectives, and reflect them in policy. Local air pollution has long been a driver of programs to modernise industrial installations and reduce the burning of coal in and around cities. Recent extreme air pollution in Beijing and other cities served to further galvanise public discontent about the impacts on health and daily quality of life. Cutting pollution is now an urgent policy priority tied to maintaining social order.

Climate change also is recognised as a real and pressing concern in China, including for the risk of drier conditions in the northern parts of the country. This could exacerbate water shortages, with potentially destabilising effects on the economy and society, and require very large investments in infrastructure to pump water from the south of the country. China is large enough for its own greenhouse gas emissions trajectory to influence global climate change outcomes. Furthermore, China's actions on climate change are likely to influence other countries, thus amplifying the effect of Chinese policy decisions.

A further factor motivating change (Boyd 2012) is the desire for leadership in technology development and in rising manufacturing industries. Low-carbon policies are seen as a chance to foster innovation and for Chinese firms to gain dominance in emerging energy technologies, as has already happened in the manufacture of wind turbines and solar panels.

Energy security is another important policy objective pointing in the same direction. Policies to reduce energy consumption decrease reliance on imported energy including oil, and thus make the Chinese economy less vulnerable to international price shocks or geopolitical disruptions (Wu et al. 2012). China's rapid increase in coal use has also led to rapid increases in coal imports, which again can be seen to pose a risk to national energy security. Renewable energy sources (including hydro, wind and solar power), in contrast, do not depend on international trade. There is a clear synergy between the objectives to reduce emissions, air pollution and climate change and to improve energy security.

One view of the potential for change and the pace of China's modernisation holds that these new policy efforts have every chance of success, and indeed overachievement, as has been the case with the majority of market-based schemes of pollution control the world over (Daley et al 2011), and that China's economic structure can shift quickly towards 'cleaner', more high value-added industries and the services sector (Garnaut 2012).

Under these circumstances it may be possible for China to achieve faster rates of decarbonisation than targeted now. In the words of Ross Garnaut (2013), 'over-performance against the [2015 emissions intensity] pledge seems possible and strengthening of the pledges [is] feasible in the context of increased global effort'.

Whether relatively rapid transformation to a lower-carbon economy will occur depends on political will, institutional factors, economic developments and the effectiveness of policy instruments.

Conclusions

China continues to reduce the carbon emissions intensity of its economy as a result of improvements in energy efficiency and structural change in the economy. Preliminary data indicate that emissions growth slowed markedly during 2012 and 2013, mainly due to slower growth in energy demand and coal use. Further slowdown in the growth of coal use is on the cards, making it plausible that emissions growth will be much slower over the remainder of this decade than over the last decade. Continued change in the structure of the economy, along with sustained improvements in technical efficiency, are likely to reduce the growth in energy demand.

The impetus to clean up the energy sector derives not only from climate change objectives, but also increasingly from the desire to reduce urban air pollution. This means stemming the increase of coal use through continued improvements in energy efficiency and substitution in the energy mix, with a greater role for renewable and nuclear energy.

Policy efforts play an important role. The Chinese Government has stated its intention to place greater emphasis on market mechanisms, including in climate change policy. Pilot emissions trading schemes are under way, though the real test will be whether a national scheme of carbon pricing will be created—and, if so, whether it will be effective. For pricing mechanisms to work effectively in creating incentives to cut energy use and emissions in China's economy, China's energy markets will need to see market reform.

With growing policy interest in market reform across the board in China, the issues facing its broader economic policy reform are reflected in energy and environmental policies.

References

Baron, R., Aasrud, A., Sinton, J., Campbell, N., Jiang, K., & Zhuang, X. (2012), *Policy Options for Low-Carbon Power Generation in China: Designing an Emissions Trading System for China's Electricity Sector*, International Energy Agency, Paris.

Boyd, O. (2012), *China's energy reform and climate policy: the ideas motivating change*, CCEP Working Paper No. 1205, Centre for Climate Economics and Policy, Crawford School of Public Policy, The Australian National University, Canberra.

China Daily (2007), 'Ecological civilization', *China Daily*, 24 October: 10. Available from <http://www.chinadaily.com.cn/opinion/2007-10/24/content_6201964.htm>.

Daley, J., Edis, T., & Reichl, J. (2011) *Learning the hard way: Australian policies to reduce carbon emissions*, Grattan Institute, Melbourne.

Garnaut, R. (2012), 'The contemporary China resources boom', *Australian Journal of Agricultural and Resource Economics* 56(2): 222–43.

Garnaut, R. (2013), 'China's climate change mitigation in international context' in R. Garnaut, F. Cai and L. Song (eds), *China: A New Model for Growth and Development*, pp. 281–300, Canberra: ANU E Press.

Guan, D., Liu, Z., Geng, Y., Lindner, S. and Hubacek, K. (2012), 'The gigatonne gap in China's carbon dioxide inventories', *Nature Climate Change* 2: 672–5.

Howes, S. and Dobes, L. (2010), *Climate Change and Fiscal Policy: A Report for APEC*, Washington, DC: The World Bank.

Huang, Y., F. Cai., X. Peng. and Q. Gou (2013), 'The new normaI of Chinese development', in R. Garnaut, F. Cai and L. Song (eds), *China: A New Model for Growth and Development*, Canberra: ANU E Press.

International Energy Agency (IEA) (2013a), *CO_2 Emissions Indicators 2013*, Paris: International Energy Agency.

International Energy Agency (IEA) (2013b), *World Energy Outlook 2013*, Paris: International Energy Agency.

Jiang, K., Zhuang, X., Miao, R. and He, C. (2013), 'China's role in attaining the global 2°C target', *Climate Policy* 13(sup01): 55–69.

Jotzo, F. and Pezzey, J. (2007), 'Optimal intensity targets for greenhouse gas emissions trading under uncertainty', *Environmental and Resource Economics* 38(2): 259–84.

Jotzo, F., de Boer, D. and Kater, H. (2013), *China carbon pricing survey 2013*, CCEP Working Paper No. 1305, Centre for Climate Economics and Policy, Crawford School of Public Policy, The Australian National University, Canberra.

Lewis, J. (2011), *Energy and Climate Goals of China's 12th Five-Year Plan*, Washington, DC: Pew Centre.

McKibbin, W. J., Morris, A. C. and Wilcoxen, P. J. (2011), 'Comparing climate commitments: a model-based analysis of the Copenhagen Accord', *Climate Change Economics* 2(2): 79–103.

National Bureau of Statistics (NBS) (2011), *China Energy Statistical Yearbook 2011*, Beijing: China Statistics Press.

National Bureau of Statistics (NBS) (various years), *China Statistical Yearbook*, Beijing: China Statistics Press.

National Bureau of Statistics (NBS) (various years), *Statistical Communiqué of the People's Republic of China*, Beijing: China Statistics Press.

National Development and Reform Commission (NDRC) (2013), *Market readiness proposal: establishing a national emissions trading scheme in China*, Prepared for Partnership for Market Readiness Program, The World Bank, Beijing.

Qi, S. and Wang, B. (2013), 'Fundamental issues and solutions in the design of China's ETS pilots: allowance allocation, price mechanism and state-owned key enterprises', *Chinese Journal of Population Resources and Environment* 11(1): 26–32.

Stern, D. I. and Jotzo, F. (2010), 'How ambitious are China and India's emissions intensity targets?', *Energy Policy* 38(11): 6776–83.

The Economist (2013), 'The party's new blueprint', *The Economist*, 16 November 2013. Available from <http://www.economist.com/blogs/analects/2013/11/reform-china>.

Wu, G., Liu, L.-C., Han, Z.-Y. and Wei, Y.-M. (2012), 'Climate protection and China's energy security: win-win or tradeoff?', *Applied Energy* 97: 157–63.

Xinhua (2014), 'China struggling to meet emission targets: minister', *Xinhua.net*, 21 April 2014. Available from <http://news.xinhuanet.com/english/china/2014-04/21/c_126416067.htm>.

Zhang, H. (2013), 'Design elements of emissions trading regulation in China's pilot programs: regulatory challenges and prospects', *Environmental and Planning Law Journal* 30(4): 342–56.

Zhang, Y. and Brandon, C. (2012), *Seizing the opportunity of green development in China*, Supporting report for World Bank, *China 2030: Building a Modern, Harmonious, and Creative High-Income Society*, Beijing: The World Bank.

Zhang, D., Karplus, V. J., Cassisa, C. and Zhang, X. (forthcoming), 'Emissions trading in China: progress and prospects', *Energy Policy*.

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